SCIENCE ABSTRACTS.

PHYSICS AND ELECTRICAL ENGINEERING.

JANUARY 1898.

GENERAL PHYSICS.

1. *The Process of Solidification.* **G. Tammann.** (Annal. Phys. Chem. 62. 2. pp. 280–299, 1897.)—The author seeks the most general form of the fusion-pressure curve, a precise definition of the solid state, and definite information concerning spontaneous crystallisation and rate of crystallisation. A knowledge of the latter is required for judging of the rate at which an undercooled liquid passes into the solid state. If a discontinuity of properties is made the basis of distinction between solid and liquid, the conclusion is arrived at that only crystallised bodies are in the solid state. For as far as experience goes, it is only during crystallisation that a discontinuous process sets in. Amorphous bodies must be regarded as undercooled liquids of great internal friction. The solid state is also distinguished by the fact that in it a certain group of properties depends upon direction. Amorphous bodies possess no heat of fusion. Hittorf found that the cooling-curve of liquid selenium, which hardens at 50°, is continuous. A retardation of the cooling by the evolution of heat of fusion does not take place at any point. There is a general notion that the spontaneous crystallisation capacity (*i. e.*, the number of crystalline nuclei formed during unit of time) increases continuously with falling temperature. But by counting these nuclei another result is obtained. The spontaneous crystallisation capacity possesses a pronounced maximum at a certain temperature, corresponding probably to a maximum attraction between the molecules. For betol, the salicyl ester of β-naphthol, with a fusing-point of 95°, there is a maximum at 10°. The rate of crystallisation may be defined as the distance by which the boundary between crystals and undercooled liquid is displaced in unit of time. If the undercooling is less than the ratio between the heat of fusion and the specific heat of the solid substance, crystals separate out from the undercooled liquid at the boundary. These crystals are still

surrounded by liquid. The greater the undercooling, the less the quantity of liquid remaining among the crystals, until at last the liquid solidifies. If the rate of solidification is defined as that mass which is formed in unit of time at unit surface of the boundary, then the second rate of solidification will, at the temperature of total hardening, be equal to the first multiplied by the density. E. E. F.

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2. *Oxygen in the Sun.* **A. Schuster.** (Ast. Phys. Journ. 5. pp. 162–163, 1897.)—The author draws attention to the importance of the chromospheric lines at λ 5435·4 and λ 5329·1 being accurately measured by those who can work under sufficiently pure atmospheric conditions, as these lines are very near two of the oxygen triplets. If the chromospheric line could be proved triple, this would be a great step to the establishment of the presence of oxygen in the solar surroundings. C. P. B.

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3. *Oxygen in the Sun.* **L. E. Jewell.** (Ast. Phys. Journ. 5. pp. 99–100, 1897.)—Several papers have of late been published on this subject, with little or no definite conclusions. In the above article the author gives a concise account of his observations of the lines at wave-lengths 7772·20, 7774·43, and 7775·62 in the sun, which are amongst the suspected oxygen lines. With the great dispersion of the large concave grating at the Johns Hopkins Laboratory at Baltimore, he found the above lines to change their intensity with the varying altitude of the sun, thus definitely proving their *terrestrial* origin; and, further, their variation in intensity was quite different from that of the known atmospheric oxygen bands. This latter fact led to the lines being specially observed at times when the air had greatly different values of humidity, with the result that the above three lines, supposed to represent oxygen in the sun, are really produced by water-vapour in the earth's atmosphere. C. P. B.

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4. *Atmospheric Potential.* **R. Börnstein.** (Annal. Phys. Chem. 62. 4. pp. 680–686, 1897.)—The potential gradient above the earth's surface cannot be determined by mountain observations, since the equipotential surfaces follow the features of the landscape. Balloon observations are therefore necessary, and have been frequently resorted to. But in these the charge of the balloon itself is usually neglected. If the balloon is a conductor, it has the potential of the earth's surface to begin with. As it rises, its potential falls more and more below that of the surrounding space, since the earth's charge is negative. If it is an insulator, its charge is little affected by loss of gas or ballast. It may be due to the effect of the sunlight or to friction between the netting and the envelope. The potential observations might

be corrected for the balloon charge by taking horizontal observations at some distance from the balloon. But the technical difficulties of carrying suitable poles, etc. are very great. It is better to determine the charge of the balloon by three successive points in a vertical line. If these are, say, 2m apart, the earth's charge will be negligible. If the two vertical distances show eqnal gradients, the balloon's charge is zero. If not, its charge may be determined by the formula

$$-\frac{\partial^2 V}{\partial r^2}=\frac{2M}{r^3},$$

where V is the potential, r the distance below the car, and M the charge of the balloon. E. E. F.

5. *Elliptic Vibrations in Fluids.* **V. Crémieu.** (Comptes Rendus, 125. pp. 935–937, 1897.)—Only longitudinal vibrations can be propagated through fluids, and in these the direction of propagation coincides with that of the motion of the vibrating molecule. The author has made experiments to find whether, in spite of this peculiarity, elliptical vibrations can be demonstrated in a gas corresponding to those which are well known to be produced by the composition of two rectangular transversal vibrations having the same period and a given difference of phase. He uses two identical organ-pipes of square section, closed at one end, and crossing at right angles at a point P, which is for each of them an antinode; the walls of the pipes at this common part P are of glass. The movements of the air in this region P are examined by means of a quartz-fibre (of about 0·05 mm. diameter) attached at one end to soft wax, and placed perpendicularly to the direction of the vibrations: the free end follows exactly all the movements of the gas. The vibrations are produced by two tuning-forks of equal period, maintained electrically, and provided with square plates of the same size as the section of the pipes. Instead of arranging to maintain a constant difference of phase between the forks, it is found more convenient to regulate them so that they give, by interference, beats having a period of ten seconds. Under these circumstances the resulting vibratory motion should vary from a right line to a circle, with all the intermediate forms of ellipse. Observation of the free end of the quartz-thread shows that this is the case. D. E. J.

6. *Closed Surfaces of Discontinuous Velocity.* **W. Wien.** (Annal. Phys. Chem. 62. 1. pp. 192–203, 1897.)—In a liquid surrounded by solid walls and not subjected to rotation, no motions can occur unless discontinuities of velocity are produced. But within the liquid closed surfaces may be formed at which the velocities are discontinuous, thus producing, as it were, a complex space, within which circuital flows may take place. Such motions

may, and do, occur in the atmosphere. The author works out the mathematical conditions of some simple types of these motions in an incompressible frictionless liquid. E. E. F.

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7. *Variation of Spectrum of Orion Nebula.* (Ast. Phys. Journ. 6. pp. 363–366, 1897.)—Prof. Campbell's observations of the variable intensity of the three nebula lines at wave-lengths 4861, 4959, and 5007 having been questioned by Dr. Scheiner, additional confirmation of their change in various regions of the nebula is given by three independent observers—J. M. Schaeberle, R. G. Aitken, and W. H. Wright. All agree that in the vicinity of the Trapezium the three lines are all well marked, λ 5007 being several times as bright as λ 4861 (Hβ), while away in the neighbourhood of the star Bond 734 the hydrogen line λ 4861 is the only line visible. In another region λ 5007 was again visible, together with Hβ, but the latter was still much the brighter of the two. These observations leave little doubt as to the actual variation of the nebular spectrum. C. P. B.

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8. *Meteor Spectrum.* **E. C. Pickering.** (Nat. 57. p. 101, 1897.)—So far as is at present known, this is the first observation of any certain value bearing on the spectra of meteorites as they actually fall through the atmosphere. On June 18, 1897, a plate exposed at 11 P.M. at Arequipa, in Peru, on the region surrounding the southern constellation Telescopium, showed on development the spectrum of a meteor which had fallen during the exposure. The instrument was the 8-inch Bache telescope, with prisms outside the objective, with which most of the Draper memorial star-spectra have been obtained. The spectrum shows six bright lines, of varying intensity, whose position can only be provisionally measured owing to the absence of a comparison-spectrum with known wave-lengths. The approximate wave-lengths given are:—

λλ 3954, 4121, 4195, 4344, 4636, and 4857.

Of these, λ 4121 seems suspiciously near a line seen in one of the components of helium gas, while λ 4857 is very probably identical with the hydrogen line λ 4861 (Hβ). C. P. B.

LIGHT.

9. *Röntgen Rays.* **A. Voller** and **B. Walter.** (Annal. Phys. Chem. 61. 4. p. 806, 1897.)—The authors regret having overlooked Winkelmann and Straubel's recent work on the refraction of X-rays in copper and iron, the results of which agree more closely with their own. E. E. F.

10. *Action of Röntgen Rays on the Skin.* **L. Lecercle.** (Comptes Rendus, 125. p. 583, 1897.)—When Röntgen rays fall upon the skin, the radiation of heat from the skin is increased, and remains greater for a long time after the rays have ceased to act. In many cases the first result is a slight fall in the radiation. A. D.

11. *Röntgen Rays and Luminescence of Gases.* **A. de Hemptinne.** (Comptes Rendus, 125. pp. 428–429, 1897.)—A tube containing a gas at a very low pressure becomes luminous if exposed to electric vibrations. The same effect takes place at higher pressures if Röntgen rays be passing through it. This result is more marked in organic vapours than in simple gases, and among the former it is the more marked the higher the molecular weight. A. D.

12. *Absorption of Röntgen Rays.* **A. Buguet.** (Comptes Rendus, 125. pp. 398–400, 1897.)—By means of a sensitometer containing squares of various thicknesses, the author finds that the relative opacity to Röntgen rays, per unit of thickness, diminishes as the thickness increases, and diminishes very rapidly for the layers successively encountered. As the Röntgen rays come from tubes of increasing resistance, the first layers of tin are found to absorb the rays more powerfully, but the succeeding layers less so. An instrument is described (fluorescent screen behind a series of obstacles of graduated substance and thickness) for ascertaining the intensity of the radiation, and also the specific absorption of the radiation from any given tube. A. D.

13. *Magnetic Deviation of Kathode and Röntgen Rays.* **G. de Metz.** (Comptes Rendus, 125. pp. 426–428, 1897.)—The deviation (see Phys. Soc. Abstracts, No. 570, Oct. 1897) takes place when a layer of air intervenes, but not quite so well as when the exhausted tube containing the aluminium cylinder is directly melted on to the Crookes tube. A. D.

14. *Absorption of Röntgen Rays.* **E. van Aubel.** (Journ. de Physique, 6. pp. 528–529, 1897.)—Bromine vapour at ordinary temperatures is very transparent, liquid bromine very opaque, to Röntgen rays. A. D.

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15. *Existence of Röntgen Rays in Kathode Rays.* **A. Roiti.** (Roma, R. Accad. Lincei, Atti 6. 2. pp. 123–129, 1897.)—Some answer this in the affirmative; most say no. The Röntgen rays are broadly distinguished from the kathode rays by their not being deviated by a magnet and by their greater penetrative power; but this is a matter of degree: and so also is the turbidity of media for the kathode rays as compared with their transparency for the Röntgen rays. Röntgen himself seems to regard the idea of a shading off of the one into the other without disfavour. But there is some distance between this and the assertion that the Röntgen radiations are obtained from the kathode radiations by simple subtraction; and this latter does not appear to be the case, for the following reasons:—(1) The phenomena of discharge and ionisation are inexplicable on this hypothesis. (2) Every point of a body under kathode rays gives off Röntgen rays *in all directions.* (3) Deviate the kathode rays in the tube, and photographic and screen images are displaced and modified: this would not occur if they were due to Röntgen rays, not deviable, and pre-existent among the kathode rays. (4) If there be any undeviable rays among the kathode rays, these, in their intensity, fall far short of the Röntgen rays from the same tube. (5) The analogy of calorescence or of fluorescence is sufficient as providing an explanation. (6) Kathode rays which have traversed a thin layer emerge into air or a vacuum as kathode rays, not as Röntgen rays. (7) Reflection of kathode rays is irregular because surfaces are never sufficiently smooth, even optically smooth surfaces being rough in relation to these rays. (8) Röntgen rays come from an appreciable depth beneath the surface; they, therefore, do not follow the cosine law, but are the same in all directions. As we increase the thickness of the aluminium window we pass from Lenard's condition, transmission of kathode rays, to Röntgen's, viz. production of Röntgen rays. Photography within a tube, under black paper, etc., not too thin, is, therefore, a Röntgen-ray effect. (9) Lenard missed the Röntgen rays through having his aluminium windows too thin: it then seemed as if the whole of the radiation was deviated by the magnet. Also, his screen was fluorescent to kathode, but not to Röntgen, rays. (10) In a focus-tube the radiations from the anti-kathode contain other radiations than Röntgen rays, also said to differ from the kathode rays in respect that they cannot excite Röntgen radiation and are not produced from the incident beam either by regular or by diffuse reflection. They do, however, excite a feeble Röntgen radiation, and the want of regular reflection is explained above.—Experiments are described to confirm the result that the Röntgen radiation is due to transformation and not to simple subtraction. It is shown that probably there exist no undeviable

kathode rays, or, if they exist, they are not transformable into Röntgen rays. Eliminating the effects of occluded or adherent gas, it is found that different metals, in the pure state, have powers of emitting Röntgen rays under kathode-ray impact which increase regularly, not with the density or with the atomic volume, but with the atomic weight. A. D.

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16. *Infra-red Rays.* **J. Königsberger.** (Annal. Phys. Chem. 61. 4. pp. 687–704, 1897.)—The author describes some extensions of Merritt's work on the absorption and pleochroism of crystals for infra-red rays. The substances examined were baryta, celestine, gypsum, calcspar, aragonite, cerussite, quartz, amethyst, mica, biotite, and beryllium. In comparing the transparency-curves of calcspar and aragonite, it was found that for vibrations along the axis which in twinned aragonites corresponds to the hexagonal axis of the calcspar, the curve is similar to that for the extraordinary ray in calcspar. This may be connected with the fact, mentioned by Ångström, that the state of aggregation of a substance has often little influence upon its transparency. Bunsen also noticed that crystallised and dissolved didymium sulphate had practically the same sharp absorption-bands, and in the case of gypsum it appears that water of crystallisation has only little influence. Pleochroism at any part of the spectrum is usually due to a slight displacement of one transparency-curve with respect to that for another crystalline axis. Such pleochroism for the invisible rays is especially strong in calcspar and aragonite.

E. E. F.

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17. *Le Bon's "Dark Light."* **H. Becquerel.** (Journ. de Physique, 6. pp. 525–528, 1897.)—Le Bon's results are not due to the transparency of ebonite to white light (Perrigot), so much as to its great transparency to the least refrangible red and the infra-red. These rays extinguish the phosphorescence of a luminescent screen, which remains less affected where a metal object, such as a coin, has sheltered the screen from these rays. Further, if a photographic plate be slightly fogged by white light, these rays— particularly those in the neighbourhood of line A—continue the action on the film, as Becquerel *père* found with daguerreotype plates in 1840. Behind a coin, therefore, the fog remains as at first, while round it the deposit of silver is dense. The exposure must be prolonged, but if it be too prolonged the phenomena of "reversal" may appear and the region outside the coin may clear up, leaving the original condition of fog beneath the coin. Precisely similar results may be obtained with red glass instead of ebonite. Ebonite 0·6 mm. thick transmits 0·04 of the dark heat from a copper plate at 400°, but hardly any of that from the same plate at 100°. A. D.

18. *Photography of Fluorescent Image.* **Ch. Porcher.** (Comptes Rendus, 125. pp. 409–410, 1897.)—There is nothing gained, either in time or in definition, by photographing the shadow image produced on the fluorescent screen by Röntgen rays.
A. D

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19. *Grey and Red Incandescence.* **O. Lummer.** (Annal. Phys. Chem. 62. 1. pp. 14–29, 1897.)—H. F. Weber observed in 1887 that the first appearance of light in a glowing substance is not red, but a misty grey, which flits about and cannot be accurately located with the eye. This is explained by the author on the assumption that the grey glow is a sensation of the rods in the retina, and the red glow a sensation of the cones. When the grey glow sets in (about 400°) the fovea centralis is unaffected, since it contains cones only. It is, therefore, impossible to fix the eye upon the glowing body, which is only seen by the peripheral regions of the retina. As soon as the red glow begins the centre of vision is brought into play, and the image becomes steady.
E. E. F

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20. *Observation and Theory of Zeeman Effect.* **A. Cornu.** (Comptes Rendus, 125. pp. 555–561, 1897.)—Zeeman's arrangements (Phil. Mag., July & Sept. 1897) are modified as follows: In the focal plane of the eye-piece with which the spectrum is observed is placed a steel needle perpendicular to the spectral lines. Behind the eye-piece is placed a Wollaston doubly-refracting prism, and this is adjusted so that the two images of the needle which it produces have a common edge. We thus have two adjacent strips, one (A) polarised parallel to the spectral lines, the other (B) at right angles to them. Before exciting the electromagnet, the prism is arranged so that the polarised spectra exhibit no discontinuity at their common edge. The effect of exciting the magnet when we observe a bright spectral line derived from a pencil of rays perpendicular to the lines of force, is that the part of the line which is in B becomes doubled; the part in A becomes narrower and lies halfway between the two bright lines in B. The conclusion is that each original non-polarised ray is transformed into a triplet the exterior components of which are completely polarised parallel to the lines of force, while the interior component is completely polarised at right angles to them.

A second observation is made (through a hole in one armature) on a pencil parallel to the line of force. Between the eye-piece and the prism is introduced a quarter-wave plate of mica so that its principal planes are inclined at 45° to those of the prism. When the magnet is excited the two parts of the bright line become narrower, and there is a break at the line of separation of the spectra. When the mica-plate is turned through a right angle the relative position of the two parts is reversed; the same reversal is also produced by reversing the magnetic field. It is inferred that the magnetic field transforms each primitive ray into two, both circularly polarised, but in opposite senses.

After describing another method of observation by means of a Nicol's prism and plates of mica, the author gives a kinematical interpretation, based upon Fresnel's resolution of a plane-polarised ray into two equal and opposite circularly polarised rays, and Ampère's proposition that a line of magnetic force is equivalent to the axis of a solenoid whose austral pole is to the left of the current. The inference drawn is that "the action of the magnetic field tends to resolve those rectilineal vibrations which are capable of wave-propagation into circular vibrations parallel to the current of the solenoid; those circular vibrations which are in the same sense as the current being accelerated, and those which are in the opposite sense being retarded." Attention is called to the fact that the alterations of period involved essentially distinguish the phenomenon from Faraday's rotatory effect. G. B. M.

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21. *Magneto-Optic Effects.* **P. Drude.** (Annal. Phys. Chem. 62. 4. pp. 687–692, 1897.)—The author points out that his theory of magneto-optic effects, as amplified in 1894, is as well capable of accounting for all the observed phenomena as that of Leathem. The real magneto-optic constant of his theory is complex, and there are in reality two such constants. The fundamental equations of Leathem's theory may be at once reduced to those of the author's. One of Leathem's further equations (No. 10) may be interpreted as representing a Hall effect for conduction and displacement currents, but no connection between the Hall effect and magneto-optic phenomena has as yet been actually established.

E. E. F.

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22. *Optical Phenomena in a Magnetic Field.* **A. A. Michelson.** (Ast. Phys. Journ. 6. pp. 48–54, 1897.)—With a view of testing the work of the late M. Fievez, who found that the spectral lines of a source subjected to a magnetic field were reversed and doubly reversed instead of being simply widened, the author has examined the spectra of several substances with his interferential refractometer, using the now well-known "visibility" method. Curves are given showing both distinct doubling and widening of the lines, although much evidently depends on the direction and intensity of the magnetic field. It appears that up to a strength of field of 2000 C.G.S. the chief effect is simply a doubling of the lines; beyond this strength the component lines are broadened as well as separated. The degree of separation is nearly proportional to the strength of field. The broadening effect is much more marked when the light under examination issues at right angles to the magnetic field than when it lies along the lines of force. This the author thinks may be accounted for by the radiating atoms having a new velocity impressed upon them at right angles to the original one, the resultant velocity giving the broadening effect. C. P. B.

23. *Interferential Spectroscopy.* **A. Perot** and **C. Fabry.** (Comptes Rendus, 126. pp. 34–36, 1898.)—In a former paper (C. R. 123. p. 802) the authors have shown the ease with which fringes can be obtained by means of two glass plates enclosing a thin film of air, the internal surfaces of the glasses being thinly silvered. They give here a description of the application of this arrangement to delicate spectrometry, stating that for some purposes the method is more suitable than that of Michelson. C. P. B.

24. *Related Spectra.* **C. Runge** and **F. Paschen.** (Annal. Phys. Chem. 61. 4. pp. 641–686, 1897.)—The three spectra of oxygen, sulphur, and selenium show a regular structure. They all have "compound" spectra whose lines occur in series obeying the laws indicated by Rydberg and by Kayser and Runge. There is also a connection between the three spectra. As the atomic weight increases, the spectrum as a whole moves towards the greater wavelengths. The sulphur and selenium compound spectra show some lines which have not hitherto been observed, and may help to explain some strange lines in the spectra of heavenly bodies. Besides the six triplets observed by Piazzi Smyth, the authors have found seven more in the oxygen compound spectrum, which, together with the former, make up two series. They correspond to the two series of triplets observed by Kayser and Runge in the spectra of Mg, Ca, Sr, Zn, Cd, and Hg. Two such series are also found in cleveite gas, and the argument as to the compound character of this gas from its spectrum is therefore without foundation. E. E. F.

25. *Spectral Photometry.* **D. W. Murphy.** (Ast. Phys. Journ. 6. pp. 1–21, 1897.)—After describing the double-slit collimator of Vierordt's photometer, the author describes a series of experiments undertaken to test the accuracy of Vierordt's statement that the intensity of a spectrum is proportional to the slit-width. He comes to the conclusion that it is not strictly true, the error varying from 1 or 2 per cent. in the blue to as much as 10 per cent. in the red.

In the same paper there is a useful description of an experimental determination of the truth of Fresnel's formula for the intensity of light reflected from certain media. C. P. B.

26. *Emission Spectra.* **A. C. Jones.** (Annal. Phys. Chem. 62. 1. pp. 30–53, 1897.)—Zinc and cadmium salts were placed in a discharge-tube having a narrower and a wider portion, so as to examine the influence of the intensity of the discharge upon the spectrum yielded under the discharge of an influence-machine. Mercuric haloid salts were examined in the same way. The results, which are very complex, are embodied in tables and curves. E. E. F.

27. *Formula for Wave-lengths of Spectra.* **J. J. Balmer.** (Ast. Phys. Journ. 5. pp. 199-209, 1897.)—There has long been known to be some connection between the various spectral lines of many of the elements as regards their vibration-frequency, which has hitherto only found definite expression in the case of hydrogen by the well-known Balmer's Law. Of late Runge and Paschen, of Hanover, have been specially investigating the spectra of the elements with very great dispersion, and have been successful in mapping out definite series in many bodies. They find that in general each element is represented in its spectrum by three series, one principal and two subordinate. Furnished with the accurate determinations of wave-lengths for certain metals, Balmer has been able to furnish a more universal formula, given on p. 202. C. P. B.

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28. *Effect of Pressure on Wave-length.* **W. J. Humphreys.** (Ast. Phys. Journ. 6. pp. 169–232, 1897.)—The author brings together all the available data on the question which have been previously published, and in addition gives a considerable amount of new matter. Detailed tables are given showing the change in wave-length produced by graduated increments of pressure on the arc spectra of forty-nine elements, from which certain definite functional relationships have been deduced. A short summary of the results is as follows:—

1. *Increase of Pressure* causes all isolated lines to shift towards the *red* end of the spectrum.
2. This displacement is *directly* proportional to the increase of pressure.
3. It does not depend on the partial pressure of the gas or vapour producing the lines, but upon the total pressure.
4. The displacement of the lines seems to be nearly or quite independent of the temperature.
5. The lines of bands (at least of certain "cyanogen" and aluminium-oxide bands) are not appreciably shifted.
6. The displacements of similar lines of a given element are proportional to the wave-lengths of the lines themselves.
7. Different series of lines of a given element are displaced to different extents. When reduced to the same wave-length these displacements are to each other approximately as 1 : 2 : 4 for the principal, first, and second subordinate series respectively.
8. Similar lines of an element, though not belonging to a recognised series, are displaced equally (when reduced to the same wave-length), but to a different extent than are those unlike them.
9. Displacements of similar lines of different substances are to each other, in most cases, *inversely* as the absolute temperatures of the melting-points of the elements that produce them.

10. The displacements of different lines of different elements are to each other approximately as the products of the coefficients of linear expansion and the cube roots of the atomic volumes of the respective elements (in the solid state) to which they are due.
11. Analogous or similar lines of elements belonging to the same half of a Mendelejeff group shift proportionately to the cube roots of their respective atomic weights.
12. The lines of those substances which, in the solid form, have the greatest coefficients of linear expansion show the greatest displacements. The converse is also true.
13. The displacement of similar lines is a periodic function of atomic weight, and consequently may be compared with any other property of the elements which itself is a periodic function of their atomic weights. C. P. B.

29. *Wave-length of Starlight.* **G. C. Comstock.** (Ast. Phys. Journ. 5. pp. 26–35, 1897.)—By the use of Michelson's method of producing interference-fringes at the focus of a telescope by placing over the object-glass a screen with two rectangular slits cut in it with their axes parallel to each other, the author has obtained values for the integrated intensity of the light from fifty-five stars, varying in magnitude from 0·5 to 6·5. An approximate agreement is shown between the effective wave-length and the colour of the star; so much so, that a general classification is given, from which it seems that the *white* stars have an effective wave-length about λ 5640, the *yellow or solar* stars about λ 5730, and the *red* stars with banded spectra about λ 5750. The author concludes that the light from stars which are distinctly coloured has a maximum intensity 9 $\mu\mu$ greater than that from white stars, while it is not sensibly different from that from those of the deepest red colour. C. P. B.

HEAT.

30. *Two-Liquid Phases.* **W. D. Bancroft.** (Journ. Phys. Chem. 1. pp. 647–668, 1897.)—This is a continuation of a former paper (see Phys. Soc. Abstracts, No. 395, July 1897). A graphical summary is given of the states of equilibrium in three-component systems when one pair, two pairs, and three pairs of the components can form two-liquid phases. Thirteen cases here occur, and the results are too intricate to be indicated in an abstract. The variations that occur with change of temperature are not discussed. The dependence of the conditions of equilibrium upon the relative miscibilities of the components and the dissociations that may occur is discussed. The latter have special importance in the case of equilibrium between gases and solids where no liquid phase is present and also in certain cases of equilibrium in solution; the former affect all solutions, but their effect is often negligible at certain temperatures. R. E. B.

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31. *Hygrometry.* **G. B. Rizzo.** (N. Cimento, 4. 6. pp. 241–260, 1897.)—After an historical account, with numerous references, of the progress of hygrometry from Cullen and Hutton onwards, the author describes a series of experiments in which he compared the readings of Crova's hygrometer with Chistoni's form of Regnault's instrument; he concludes that when proper precautions are taken Crova's hygrometer is very trustworthy and preferable to other condensing hygrometers. An account is then given of a comparison of the readings of Crova's hygrometer with those of the dry- and wet-bulb hygrometer: the conclusion is that, if the instrument is placed in a cage of the form generally used by Italian meteorologists, the tension of the aqueous vapour in the atmosphere may be calculated by the formula

$$f=F'-0{\cdot}000749\,H\,(t-t')+0{\cdot}0000000079\,H^2\,(t-t')^2,$$

where t is the temperature of the air, t' the reading of the wet-bulb thermometer, H the barometric pressure, and F′ the maximum vapour-tension corresponding to the temperature t'. G. B. M.

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32. *Irreversible Phenomena.* **O. Wiedeburg.** (Annal. Phys. Chem. 61. 4. pp. 705–737, 1897.)—The author seeks a general formulation for the actual processes in time which always take place in a certain "direction," and are therefore called irreversible. He treats heat in the same manner as other forms of energy. To represent the mutual influence of two bodies, he uses the categories of quantities, intensities, resistances, and energies, with the aid of which the transition law may be put into various forms. Applying the theorem of the constancy of the sum of quantities to thermal phenomena, a precise and complete expression is obtained for the

second law of thermodynamics, and it is recognised that the theorem of maximum entropy is based upon a fallacy due to imperfect formulation. The foundations of the author's studies are the "equations of condition," which express the various aspects of the condition of a body at any given time. In these equations, quantities and intensities are opposed to each other, and irreversible processes are indicated by terms of the second order. In this manner heat is effectually brought into line with other forms of energy, and is made to include some phenomena (*e. g.* after-effect) which had previously to be treated separately. E. E. F.

33. *Compressibility of Gases.* **A. Leduc.** (Comptes Rendus, 125. pp. 646–649, 1897.)—This paper is a continuation of a former one (see Phys. Soc. Abstracts, No. 603, Oct. 1897; C. R. 125. pp. 297–299, 1897). The present communication contains a much fuller table than the last, giving values of certain constants for a large number of gases, the constants not having a direct physical meaning in themselves, but being connected with the equations for the compressibility given in the former paper. The author has found a connection between these constants and some of the physical properties of the gases. J. B. H.

34. *Expansion of Gases.* **A. Leduc.** (Comptes Rendus, 125. pp. 768–770, 1897.)—From the results of a former experiment by the author on the density of one of the gases at 0° and 760 mm., and his experiments on the compressibilities of a number of gases at 16°, he has calculated their coefficients of expansion. The results are given in tabular form, and agree remarkably with those obtained by experiment.

It is impossible to give here any idea of the methods of calculation, as this paper, together with the other by the same author abstracted above, and a third referred to, form in reality one investigation, the equations of the first paper being used in the others. J. B. H.

35. *Meaning of* PV/T *in Theory of Gases.* **C. Del Lungo.** (N. Cimento, 4. 6. pp. 273–277, 1897.)—This is a continuation ot a polemic with Professor Boggio-Lera. The value of R (=PV/T) for hydrogen is nearly the same numerically as the mechanical equivalent of heat; the author proves that this circumstance is quite accidental. G. B. M

SOUND.

36. *Organ-pipe with Movable End.* **Neyreneuf.** (Annal. Chim. Phys. 12. pp. 140–144, 1897.)—The author investigates the variation in pitch and quality of the note given out by an organ-pipe which is rapidly shortened or lengthened by the movement of the end of the pipe towards or away from the mouth. J. W. C.

37. *High Pitch.* **C. Stumpf** and **M. Meyer.** (Annal. Phys. Chem. 61. 4. pp. 760–779, 1897.)—The authors tested the usual sources of very high notes, viz. Galton's whistle, Appunn's whistles, Appunn's small tuning-forks, and König's forks. They found very serious discrepancies between the indicated and the actual values. The tests were carried out by the method of difference tones. The highest note audible on Galton's whistle was 14,000. It was found important to have a constant air-pressure, as the pitch may vary 10 per cent. on varying the blast. Appunn's pitchpipe no. 62, supposed to give a note of frequency 50,880, was actually found to give one of 10,900. The cause of all these discrepancies lies in the fact that there is no continuous rise of pitch in the series, and this defect can only be discovered by very careful attention to the gaps. E. E. F.

38. *Acoustic Resonators.* **P. Lebedew.** (Annal. Phys. Chem. 62. 1. pp. 158–173, 1897.)—The author investigates the ponderomotor forces due to the mutual influence between the exciting wave and the forced vibrations of the resonator, as distinguished from the direct action of the wave and the reaction of the resonator. He uses a Kundt rod as a source of sound, and a short thin-walled glass tube, tuned by a cork stopper, as resonator. He finds that a plane wave falling on the resonator repels it from the source. This repelling force is a maximum for perfect unison. In the immediate neighbourhood of the source, the analogy between the behaviour of acoustic and electromagnetic resonators is perfect. E. E. F.

ELECTRICITY.

39. *Electric Conductivity of Discontinuous Conductors (Coherers).* **E. Branly.** (Comptes Rendus, 125. pp. 939–942, 1897.)—Marconi's experiments have again drawn attention to the electrical behaviour of tubes of metallic filings, and generally to the conductivity of discontinuous conductors. The author has made further experiments on the best conditions for sensitiveness, and the results confirm those first announced by him in 1891 (*cf.* La Lumière Electrique, May & June, 1891). He objects to the name 'coherers' given by Lodge to his tubes. D. E. J.

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40. *Dielectric Strength of Oils.* **E. F. Northrup** and **G. W. Pierce.** (Elect. World, 30. pp. 559–560, 1897.)—The oils under test are subjected to pressures from a high-frequency coil, a transformer, and an induction-coil. The high-frequency coil was capable of giving a smooth continuous discharge through 10 inches of air; the induction-coil gave a heavy 4-inch spark, and the same coil used as a transformer with 100 volts on the primary discharged through about half an inch of air. In the following table, which is a brief summary of the results, the numbers give the maximum and minimum ratio of oil-strength to air-strength through the range tested.

Kind of Oil.	High-frequency Coil.	Transformer.	Induction-Coil.
Transit	14—24·8	7·8—·9	3·9—9·7
Engine	29·1—37·2	5·8—·99	3·9—16
Kerosene....	47·6—67·5	21—26·6	10·3—35

These results show that kerosene is the best insulator. W. G. R.

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41. *Dielectric Strength of Oils.* **C. P. Steinmetz.** (Elect. World, 30. pp. 609–610, 1897.)—The author quotes some results given in a paper by Messrs. Northrup and Pierce in the 'Electrical World' of November 6th, viz.:—

First.—The ratio of oil-strength to air-strength depends upon the source of power, being lowest under the strength of alternating currents, highest with oscillating currents of a high frequency, and intermediate with the current of an induction-coil.

Second.—The ratio of oil-strength to air-strength increases with the striking distance, that is, the voltage, except with heavy oils and alternating currents.

Third.—In the latter case the strength of oil falls to, or even below, that of air at high voltages.

He does not think that the shape of the wave is the cause of these differences, but rather the powerfulness of the source of supply. He also remarks that in his opinion dry oils have a dielectric strength far superior to that of air at high voltages with alternating currents. W. G. R.

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42. *Electric Discharge.* **H. Ebert** and **E. Wiedemann.** (Annal. Phys. Chem. 62. 1. pp. 187–191, 1897.)—A cylindrical cage with fine meshes is made partly to fill up a vacuum-tube. The end walls act as supernumerary anode and kathode respectively, the light being most intense at the end of the cage farthest away from the end of the tube. When the cage fills up nearly the whole of the tube, the discharge has considerable difficulty in passing at all. Rarefied gases are often better conductors than metals. E. E. F.

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43. *Insulating Materials.* **F. W. Phisterer.** (Elect. World, 30. pp. 554–556, pp. 583–585, and pp. 610–611, 1897.)—The requirements of a good insulating substance are that it should be waterproof, fireproof, tough, flexible; it should possess the power of closing again any cracks which may occur in it from any cause, and it should be easy of application and cheap to manufacture, as well as being a good insulator.

The author considers many insulating substances, such as sulphur, silex, various asphalts, pitches, mineral wax, sapho, ozite, and paraffin wax, and gives a very complete account of what is known of their various physical qualities. Mixtures of these substances are also dealt with, and an amount of information on the subject is given which is not obtainable elsewhere in a collected form. W. G. R.

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44. *Action of Radiation on Sparks.* **A. Sella.** (Roma, R. Accad. Lincei, Atti 6. 2. pp. 184–191, 1897.)—The author describes a quantitative method of studying the action of the radiation from one spark on another. Across the terminals of the gap of the latter spark is connected a coil of wire which is placed in a vessel, of 5 litres volume, containing air. When a discharge passes part of the current goes through the coil, and the heat produced causes the air to expand, and thus drives a column of mercury along a tube connected with the vessel. There are some pretty and ingenious devices described, for making the vessel act at various temperatures and pressures. The effect of the radiations is to considerably diminish the quantity of heat produced in the shunt-coil. A. Gs.

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45. *Ballistic Galvanometers.* **M. Wien.** (Annal. Phys. Chem. 62. 4. pp. 702–705, 1897.)—Describes a method of standardising a ballistic galvanometer by means of a coil of known self-induction. It is a reversal of Maxwell's method for measuring self-inductions by the Wheatstone bridge and a ballistic galvanometer. Since

self-inductions can be more correctly determined by alternating currents, this reversal has a distinct advantage. The theory of the method results at once from Maxwell's equations. The constant of the galvanometer is

$$b = \frac{Jp}{4a(r_0 + r)},$$

where J is the constant current, p the self-induction, a the deflection, r_0 the resistance of the galvanometer circuit, and r that of each bridge branch. To avoid heating, the deflection should only be measured at break of the current. E. E. F.

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46. *Hall Effect in Liquids.* **F. Florio.** (N. Cimento, 4. 6. pp. 108–113, 1897.)—The author continues his discussion with Bagard as to whether the Hall effect exists in liquids, and still holds a negative opinion. A. Gs.

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47. *Absorption of Waves in Electrolytes.* **A. Eichenwald.** (Annal. Phys. Chem. 62. 4. pp. 571–587, 1897.)—Maxwell's fundamental equation

$$\frac{\partial^2 X}{\partial t^2} + \frac{4\pi\sigma}{\epsilon} \cdot \frac{\partial X}{\partial t} = \frac{V^2}{\mu\epsilon} \frac{\partial^2 X}{\partial z^2}$$

can only be fully tested by investigations bearing on the propagation of electric force in conductors, since it is only in these that all the terms come into action. The electric conductivity of electrolytes has an important bearing on this matter. The author used a modification of Zeeman's method, in which the absorption is followed along wires laid through the electrolyte by means of a bolometer, and obtained results which are in close agreement with Maxwell's equation. E. E. F.

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48. *Luminous Excitation of a Gas.* **H. Ebert** and **E. Wiedemann.** (Annal. Phys. Chem. 62. 1. pp. 182–186, 1897.)—The authors deal with the conditions under which a low-pressure gas is excited to luminosity in a high-frequency alternating field. The ordinary appearance of the tube with flat ends shows the kathode phenomenon (dark space and glow) next the plates, and the positive light in the middle, separated on each side by a dark space. If exhaustion is carried very far, the two kathode-spaces gradually displace the positive light and finally they coalesce. As soon as this happens the luminosity ceases altogether. This phenomenon is not a mere question of pressure. For, if four bulbs of various dimensions are simultaneously exhausted by the same pump and placed in position, the extinction takes place first in the smaller bulbs. If the diameter is reduced tenfold, the pressure at which extinction takes place is increased 22 times. But the length, and not the width, is the determining factor. It is immaterial whether the ends of the cylinder are of glass or

metal, and the nature of the gas is without influence. If the kathode formation is deflected aside by a magnet, the tube lights up again. E. E. F.

49. *The Resistivity of Reostene.* **E. Van Aubel.** (Journ. de Physique, 6. pp. 529–531, 1897.)—This alloy, a nickel-steel, due to W. T. Glover, Salford, brazes easily and can be soldered with ordinary solder. Its density is 7·8991. The resistivity at 0°·44 is 77·07 microhm-centimetres, with a coefficient of variation of 0·00119 between 0°·44 and 14°·47, of 0·00116 between 15°·6 and 57°, of 0·00114 at 74°·1 and of 0·00098 between 74°·1 and 100°·5. The resistivity is thus very high and the coefficient of variation is fairly constant between 0° and 74° C., a property which other alloys do not possess. When this alloy is cooled to 0° C. after being heated, it regains its original resistivity completely. A. D.

50. *Permanence of Resistance-Coils.* **W. E. Ayrton.** (Electn. 40. pp. 39–40, 1897.)—In 1894 the resistances of two coils of manganin and two coils of platinum-silver were tested by Glazebrook at Cambridge. In 1896, and again in 1897, the same four coils were tested by Cardew at the Board of Trade laboratory. The results agree fairly well as regards the *resistance* of the coils, comparing the 1894 with the 1897 tests, but there is disagreement between the 1894 results and those of 1896—in one coil of 10 ohms (platinum-silver) there is a difference of the order of 0·001 ohm. Again, comparing the *temperature coefficients*, the original 1894 values are in all cases lower than those calculated from the 1894, 1897, resistance tests; this is especially the case with the two manganin coils. The rate of change of the temperature coefficient of the two platinoid coils respectively appears here to be the same; similarly for the two manganin coils. But this latter result does not obtain true for calculations based on the 1896, 1897, tests. The author concludes that when tested in 1896 the coils were under abnormal conditions. R. A.

51. *Our Knowledge of the Value of a Resistance.* **W. E. Ayrton.** (Electn. 40. pp. 149–150, 1897.)—After stating the limits of accuracy of a determination of an ohm given by the Board of Trade, viz., one-hundredth of 1 per cent., the author enquires whether this same percentage accuracy is attainable for a resistance of any value, whether this value be 100,000 ohms, 10,000 ohms, or small such as $\frac{1}{10000}$ ohm. The answer is given in the negative, and it is stated that for low resistances like the last named it would be difficult to attain an accuracy of 1 per cent. by direct comparison with a Board of Trade Standard ohm. The author then states that by means of a properly constructed Lorenz apparatus, a resistance of 100 microhms could with ease be obtained in absolute measure to an accuracy of one part in a

thousand, and with sufficient care to probably two or three parts in ten thousand. For this reason it is advocated that the Government should possess a well-constructed Lorenz apparatus, and that the ultimate standard of resistance should be defined as the most accurate result obtainable by means of it. At present we can only say that the resistance of any particular conductor lies between limiting absolute values differing from one another by perhaps as much as four parts in ten thousand. W. G. R.

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52. *Glow in a High-frequency Field.* **H. Ebert** and **E. Wiedemann.** (Annal. Phys. Chem. 62. 1. pp. 174–181, 1897.) —The authors enclosed insulated wires and rods in exhausted bulbs placed between the terminal condenser-plates of a Lecher wire system. If a metallic rod lies parallel to the axis of the condenser, a slight evacuation suffices to show a blue glow-light against both ends of the rod on the glass surface, which spreads out in all directions, and shows figures resembling the positive forms of Lichtenberg figures. As the pressure is diminished the glow extends towards the dark centre of the rods until the ends are joined by a red bridge of light across the middle of the rod. Outside the red light is a dark space, which is succeeded by an equatorial hollow cylinder of reddish light. When exhaustion is carried still further, the various strata coalesce and the appearance begins to resemble that of a bulb without a rod in it. On substituting cylinders for the bulbs and mounting them with their end surfaces towards the condenser-plates, the ends of the rod are observed to glow at pressures as high as 50 mm., and at the same time cones of light, separated by positive glow, converge from the end surfaces towards the end of the rod. At 1 mm. pressure the glow covers the whole rod, and forms a bridge at the centre. The formation of the bridge occurs the earlier the narrower the rod. It may be retarded by using several parallel wires, or by substituting a tube for a rod of the same diameter.

E. E. F.

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53. *Voltage of an Induction-Coil.* **A. Oberbeck.** (Annal. Phys. Chem. 62. 1. pp. 109–133, 1897.)—The efficiency of an induction-coil should be specified in terms of its maximum voltage instead of its maximum length of spark. The voltage of a terminal may be investigated by attaching to it a needle-point and gradually approaching a charged conductor to it. The potential at any point from the spherical conductor is easily calculated. The distance at which the first permanent deflection of the electrometer connected with the needle-point takes place is called the critical distance, and marks the discharge potential. Measurements thus made show that for a given apparatus and interruptor the ratio of the maximum voltage of the secondary to that of the primary is very nearly constant. E. E. F.

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54. *Capillary Electrometer.* **U. Behn.** (Annal. Phys. Chem. 61. 4. pp. 748–759, 1897.)—This is an experimental test of Warburg's conduction-current theory of the capillary electrometer, which, as far as it goes, results in a verification of that theory. If it is the solution of a mercury-salt which reduces the surface tension of the mercury, this salt must be proved to exist, and its nature must be investigated. To do this, the author employed two beakers containing mercury and sulphuric acid, and joined by a siphon containing an earthenware diaphragm. A current was sent through the mercury, the liquid, and the mercury in the other vessel. A salt was actually formed, and proved to be mercurous sulphate. A quantity of this salt was then added to the kathode liquid. The same salt was then observed to be formed in the anode liquid, by solution of the anode. When the Hg_2SO_4 was added to both liquids to saturation, crystals of the substance were precipitated in the anode liquid, and mercury was at the same time deposited in the kathode vessel. The amount of mercury so deposited was 94 per cent. of the amount expected from the voltameter readings. The remaining 6 per cent. are not yet accounted for. E. E. F.

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55. *Rotating Magnetic Field.* **O. Colard.** (Écl. Électr. 12. pp. 585–591, 1897.) Continuation of the paper mentioned in Phys. Soc. Abstract, No. 677, 1897.—In the former paper M. Colard discussed the case of polyphase currents on the surface of a cylinder parallel to its axis, the current through any generating line situated at angle α measured from a fixed generating line being at any instant $\mathrm{I}\sin\alpha$. In the present paper he assumes the system of currents to consist of many sheets, the current being $\mathrm{I}\sin\mathrm{M}\alpha$. He finds in this case, for the radial and tangential magnetic forces respectively:

$$a_{\mathrm{M}}=\int_0^{2\pi}\frac{\mathrm{I}\sin\mathrm{M}\alpha\sin\alpha d\alpha}{1+h^2-2h\cos\alpha},$$

$$b_{\mathrm{M}}=\int_0^{2\pi}\frac{\mathrm{I}\cos\mathrm{M}\alpha\cos(\alpha-h)d\alpha}{1+h^2-2h\cos\alpha}.$$

Here, if R be the radius of the cylinder, H the distance from the axis of the point considered, $h=\frac{\mathrm{H}}{\mathrm{R}}$.

The method adopted is to find the values of these expressions for the case $\mathrm{M}=2$; as in the former paper he found it for $\mathrm{M}=1$; then to deduce from these results the probable general solution, and to prove that if this hold for M and $\mathrm{M}-1$, it holds for $\mathrm{M}+1$, and is thus established by induction.

For $\mathrm{M}=2$, $a_2=\pi h\mathrm{I}$ or $\frac{\pi\mathrm{I}}{h^2}$, $b_2=-\pi h\mathrm{I}$ or $\frac{\pi\mathrm{I}}{h^2}$, according as the point considered is interior or exterior. The system is then, for an interior point:

$$a_1 = \pi I, \qquad b_1 = -\pi I, \text{ (as shown in the former paper)}$$
$$a_2 = \pi I h, \qquad b_2 = -\pi I h;$$

for an exterior point:

$$a_1 = \frac{\pi I}{h^2}, \qquad b_1 = \frac{\pi I}{h^2},$$
$$a_2 = \frac{\pi I}{h^3}, \qquad b_2 = \frac{\pi I}{h^3}.$$

From which he assumes for the general formula:

$$\text{For an interior point, } a_M = \pi I h^{M-1}, \quad b_M = -\pi I h^{M-1},$$
$$\text{For an exterior point, } a_M = \frac{\pi I}{h^{M+1}}, \quad b_M = \frac{\pi I}{h^{M+1}},$$

and this is proved to be true by induction. By these means can be calculated (1) the force at any point in space, (2) the equation to the lines of force, (3) the equation to the equipotential surfaces. Finally, if the constant current I sin $M\alpha$ be replaced by an alternating infinite phased current, the magnetic field, as above defined, will turn round the axis of the cylinder with uniform velocity.

(1) The intensity of the field will be constant since it is a function of h only.

(2) The direction of the field at any point turns with uniform angular velocity M times the velocity of rotation of the plane of the zeros, that is with a frequency equal to that of the alternating currents.

(3) In the interior of the sheet the rotation is in the same direction as that of the plane of the zeros. In the exterior it is in the reverse direction. S. H. B.

56. *Magnetism and E.M.F.* **A. H. Bucherer.** (Annal. Phys. Chem. 61. 4. p. 807, 1897.)—A correction of the author's recent paper (see Phys. Soc. Abstracts, No. 93, Feb. 1897) on the calculation of thermo E.M.F.'s, taking into consideration the external work due to evaporation and subsequent condensation. The equations acquire a form analogous to those of Kelvin, but the final result is the same as before. E. E. F.

57. *Magnetic Screening.* **J. A. Erskine.** (Annal. Phys. Chem. 62. 1. pp. 145–157, 1897.)—A glass-hard steel needle, when magnetised, is a good test for rapid electric oscillations; they act like percussion and partly demagnetise it. The author utilises this property for measuring the screening action of metallic cylinders against the influence of a rapidly varying magnetic field, produced by the discharge of a Leyden jar fed by an influence-machine. He introduces coils of various sizes into the circuit of the condenser, and determines the demagnetising effect of each

coil upon the same steel needle magnetised to saturation. He then surrounds the needle by a screen in the shape of a glass tube covered with tinfoil, and discharges through a stronger coil so as to obtain the same demagnetising effect as before. One of the most interesting results obtained is that the screening action is almost annulled by slitting the metallic covering lengthwise. The screening action increases with the diameter and with the thickness of the tinfoil tube. The connection with the thickness is complicated, and is only approximately represented by the formula $H(1-e^{cx})$, where H is the field and x the thickness. The screening action is greatest when the first half-oscillation acts in favour of the existing magnetisation. Most of these peculiarities are easily explained by the ordinary theory of induction, regarding the tinfoil as a secondary circuit in which the induced currents tend to neutralise the variations of the field. As regards, for instance, the influence of the diameter, it must be remembered that an increase of diameter means an increase of resistance, self and mutual induction, and also an increased difference of phase.
E. E. F.

58. *Magnetic Units.* **E. Brylinski.** (Écl. Électr. 12. pp. 591–596, 1897.)—In this second and concluding part of his paper the author gives a complete dimensional table in terms of K, L, M, T, and proposes a new system of practical units, with a corresponding new nomenclature.
G. B. M.

59. *Magnetisation of a Ring.* **J. Sauter.** (Annal. Phys. Chem. 62. 1. pp. 85–108, 1897.)—The author investigates the distribution of the magnetic flux in partially-wound rings of various dimensions and excited by various magnetising currents. One ring consisted of iron wire, the other of rings of sheet-iron. The dispersion can be represented by

$$\frac{F_{\max}-F_{\min}}{F_{\max}}=\frac{2(M_1+M_3+\ldots\ldots)}{M_0+M_1+M_2+\ldots\ldots}\left(1+\frac{\delta}{m_{\max}}\frac{1}{1+4\pi\kappa'}\right),$$

where F is the flux, M the magnetic moment of a section, and δ a constant introduced to correct the tangential susceptibilities according to the relation

$$\kappa=\kappa'+\frac{m}{2\pi R}\delta.$$

As regards magnetising effect in the gramme-ring, the armature current is equivalent to a homogeneous field of the strength $4Ni/\kappa$.
E. E. F.

60. *Magnetic After-effect.* **I. Klemenčič.** (Annal. Phys. Chem. 62. 1. pp. 68–84, 1897.)—The laws of the magnetic after-effect are as yet little known. In particular, the course of the after-effect within the first few seconds after making the magnetising current has not been investigated, Ewing's values beginning

5 seconds afterwards. The author has studied this question, as well as that concerning the dependence of the after-effect upon the dimensions of the magnetised rod and upon the field-intensity. To obtain some answer to the first question he used a combination of the ballistic and magnetometric methods. The rods used were of soft iron, tempered or untempered, and of steel. Their length was 50 cm. and their thickness 0·6 cm. The curves of magnetisation show that induction is very nearly complete in steel 0·0312 seconds after magnetisation, whereas an after-effect is perceptible in soft iron subsequent to that interval. The magnetic after-effect is, however, almost exclusively confined to weak fields. It decreases as the field-intensity grows, especially if the rod or iron is thin. The after-effect cannot be eliminated by strong magnetisation. Nevertheless, it is a temporary property, which is strongest just after the specimen has been raised to a red-heat, and gradually diminishes as time goes on. E. E. F.

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61. *Determination of the Ohm.* **W. E. Ayrton** and **J. V. Jones.** (Electn. 40. pp. 150–152, 1897.)—This determination is obtained by means of a Lorenz apparatus made by Messrs. Nalder Bros. for the McGill University, Montreal. The field-coil consists of 201 turns of double silk-covered copper wire, wound in a helical groove of pitch 0·025 in. on the surface of a marble cylinder. The mean outside diameter of the coil is 21·04818 in. as measured in a Whitworth machine. The diameter of the disc is 13·01997 in. and the axial length of the helix 5·025 in. From these data the calculated coefficient of mutual induction between the coil and the disc is 18037·51 in. or 45814·45 cms.

The method of making the observations is the same as that employed by Prof. Jones with the Cardiff apparatus (see Phil. Trans. 1891, A. pp. 1–42). The facility of taking readings is increased by the use of an Ayrton-Mather narrow-coil galvanometer, the data of which are as follows:—

Resistance of suspended coil......	1·9 ohms.
,, ,, coil and suspension..	5·75 ohms.
Periodic time of complete swing ..	7·6 seconds.
Scale distance actually used	1412 millimetres. 1340 scale-divisions.
Deflection in divisions at actual scale-distance used..........	137 per micro-ampere. 23·8 per micro-volt.

The resistance-coils used were those previously employed in the Cardiff determination of the ohm.

The mean of nine determinations gives a result of 1·000294, or correcting for rate of the clock, which lost at the rate of 3 seconds in 24 hours, the result is

One Board of Trade ohm = 1·00026 true ohms.

Suggestions as to improvements of the Lorenz apparatus are then given. W. G. R.

ELECTRO-CHEMISTRY AND CHEMICAL PHYSICS.

62. *Liquefaction of Fluorine.* **H. Moissan** and **J. Dewar.** (Comptes Rendus, 125. pp. 505–511, 1897.) A continuation of the paper of May 1897 (C. R. 124. p. 1202; Phys. Soc. Abstracts, No. 558, Sept. 1897).—The boiling-point of fluorine is very near to −187° C. At −210° it is still very mobile. An interesting accident, by which air entered and was instantly liquefied, produced two layers in the tube—the upper, colourless, of liquid air; the lower, of a pale yellow, being fluorine.

Physical Properties.—Substances of known density were immersed in the liquid, it being first ascertained that at that temperature (−200°) they were not attacked, if they had been previously sufficiently cooled. In one case, when this precaution had been neglected, a fragment of caoutchouc took fire on the surface of the liquid, and burnt with intense brilliancy without any deposit of carbon. It was found that wood, caoutchouc, and ebonite floated on the liquid, methyl oxalate sank, while amber remained suspended and became almost invisible. Hence the specific gravity of liquid fluorine may be taken as 1·14, and its refractive index about the same as amber. Its diminution of volume from −187° to −210° was $\frac{1}{14}$. In this experiment, through the accidental exhaustion of the liquid air, a violent explosion occurred, and the apparatus was reduced to powder.

Its absorption-bands could be observed in any of the specimens in a layer of 1 centim. The liquid was not magnetic. The capillarity is low, capillary tubes plunged into different liquids giving a height in millimetres of:—fluorine 3·5; oxygen 5·0; alcohol 14·0; water 22·0.

Action on various substances.—Hydrogen instantly combines with fluorine even at −210°, with great heat and light. Oil of turpentine explodes with a deposit of carbon. As a striking proof of the intense activity of fluorine, when, on several occasions, a little of the liquid was dropped on the floor, the wood caught fire.

Oxygen.—The detonating body mentioned in the previous paper was further studied. The conclusion is that this body, which is only formed in the presence of moisture, is an unstable hydrate of fluorine, although it was found that liquid fluorine did not react on water until the initial temperature of −210° was raised, when an energetic action ensued under strong formation of ozone.

Mercury was not attacked at the low temperature.

Conclusions.—Fluorine is liquefied with facility at the temperature of ebullition of liquid air. Its boiling-point is near −187°. It is soluble in all proportions in liquid oxygen or air. It does not solidify at −210°. The other conclusions are embodied in the abstract. S. G. R.

63. *Densities of Liquefied Gases.*—**A. Leduc.** (Comptes Rendus, 125. pp. 571–573, 1897.)—New experiments give the following densities:—

CO_2	1·5287	Cl	2·4907
N_2O	1·5301	NH_3	·5271
HCl	1·2692	SO_2	2·2639
H_2S	1·1895		

Slight details of the modes of preparation, etc. are given.

R. E. B.

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64. *Molecular Volumes and Densities of Gases.* **A. Leduc.** (Comptes Rendus, 125. pp. 703–706, 1897.)—By means of the constants referred to in the abstract of the paper on Compressibility of Gases the author has determined the molecular volumes at 0° and the densities at 0° of the gases for which the constants were determined. These he has given in tabular form in the paper.

J. B. H.

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65. *Preparation of Percarbonate of Potash.* **P. T. Müller.** (Écl. Électr. 12. pp. 107–110, 1897.)—*Theory of Reaction.* If a solution of carbonate of potash, K_2CO_3, be electrolysed, it may be admitted, according to the theory of electrolytic dissociation, that ionisation takes place according to the form $K \mid KCO_3$. The anion formed by the radicle KCO_3 is directed towards the anode, and there, if suitable conditions exist, two of these radicles may combine to form the molecule $KCO_3 - CO_3K = K_2C_2O_6$.

Preparation of the salt.—Electrolysis takes place in two cylindrical vessels surrounded by a freezing mixture. The central vessel is porous and contains the kathode and a dilute solution of carbonate. The external vessel contains the anode, which is of platinum (iron, nickel, copper, or silver would be rapidly attacked). During the process of electrolysis a concentrated solution of carbonate of potassium is introduced into the lower part of the anode-chamber by means of a funnel and tube; the percarbonate liquor which is formed (and in which the greater part of the new salt is found in suspension) is lighter than the solution of carbonate, and can be collected drop by drop. This is then filtered by suction, and a moist product is obtained containing 87 to 93 $^{o}/_{o}$ of percarbonate. The output is 2·2 to 2·4 grammes of solid salt per ampere-hour. (The theoretical output, assuming no losses due to dissolution and decomposition, would amount to 3·6 grammes.) This product is then spread out on plates of porous porcelain and dried in a current of hot air. After 12 hours' desiccation the substance contained scarcely more than 6 to 8 $^{o}/_{o}$ of moisture. Towards the end of the operation the air-temperature may be increased to 40°. A higher temperature than this gradually decomposes the salt.

The author then deals with the conditions of preparation:—If at the commencement of electrolysis the temperature is $-15°$ and the density of the anode liquid high, then small variations of temperature produce little effect. With a decrease in the strength of the carbonate the output decreases with an increase of temperature. The concentration of the anode liquid should be as high as possible. The output is also increased by a high current-density.

Percarbonate of potassium when dry is a slightly blue amorphous powder, of a very hygroscopic nature; when damp the salt becomes bluer and gradually loses its oxygen. This salt is useful for the preparation of oxygen. When placed in water at a temperature of 45° a regular supply of gas is obtained without any application of heat, and to avoid a simultaneous discharge of CO_2 a little soda is added. Owing to its powerful oxidising properties the author considers that this salt should be of industrial use.

A. von Hansen has not yet succeeded in preparing the salts of sodium and ammonium. The manufacture of percarbonate of potassium has been patented under the title "The process of electrolytically preparing the salts of percarbonic acid" by E. J. Constam, A. von Hansen, and "Aluminium-Industrie Actien Gesellschaft," German Patent No. 91612. L. J. S.

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66. *Vapour Volumes.* **J. A. Groshans.** (Annal. Phys. Chem. 61. 4. pp. 780–789, 1897.)—The vapour volume of A grammes of a substance of molecular weight A at its absolute boiling-point B is obtained by multiplying its volume at 0° and 760 mm. by B/273. If the product is divided by the molecular volume, the vapour volume of 1 c. c. of the liquid is obtained. The molecular vapour volume is the same for all chemical bodies, and is equal to the volume of 2 g. of hydrogen at 0° and 760 mm., or 22327 c. c. Hence the vapour volume of A g. of any chemical body at its boiling-point and at 760 mm. is 22327B/273 or 81·78 B. The vapour volume of 1 c. c. is therefore obtained by dividing this quantity by the molecular volume. On applying this computation to groups of analogous bodies, it is soon seen that the vapour volume is nearly the same for all bodies of the same group. For benzol and the phenyl haloids it is approximately 290. E. E. F.

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67. *Electrolytic Analysis of Bronzes and Brasses.* **A. Hollard.** (Écl. Électr. 12. pp. 127–129, 1897.)—The author gives the details of processes for the accurate and easy estimation of copper, tin, zinc, etc. entering into the composition of bronzes and of brass. The subject is classed under the following headings:—

I. *Bronzes.—Estimation of copper* (electrolysis in acid solution). (See also C. R. vol. 123. p. 1003; Écl. Électr. vol. 9. p. 557, Dec. 1896.) Electrolysis is performed according to the methods indicated in the following articles:—C. R. vol. 123. p. 1003; Écl. Électr. vol. 9. p. 557, Dec. 1896.

Estimation of tin (electrolysis in hydrochloric solution with the addition of ammonium oxalate). The use of oxalate of ammonium for the electrolysis of tin has already been published by M. Classen, who recommends, however, working with as neutral a solution as possible. The author has found that under such condition the bath may become disturbed during electrolysis, owing to the formation of insoluble compounds of tin.

Estimation of tin by electrolysis. This process is somewhat similar to the method due to M. Riche (C. R. vol. 135. p. 226).

II. *Brass.*—The estimation of copper is performed according to the method for analysing commercial copper (see C. R. vol. 123. p. 1003, and Écl. Électr. vol. 9. p. 557, Dec. 1896). The estimation of zinc and impurities is performed according to the above processes. L. J. S.

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68. *Mutual Diffusion of Electrolytes.* **U. Behn.** (Annal. Phys. Chem. 61. 1. pp. 54–67, 1897.)—The author describes some experiments made to determine the number of ions passing across the surface of contact between two homogeneous dilute solutions of binary electrolytes. The two solutions were placed one over the other, with a free contact-surface about 5 mm. in diameter, across which diffusion took place. Such experiments were made with dilute solutions of HCl and LiCl, or HNO_3 and $AgNO_3$. The surface was made small in order to keep the two solutions sensibly homogeneous, and the duration of each experiment was one or two weeks. It was found impossible to get rid of convection altogether, and so the intrusion of ions from the opposite solution could not be confined to the immediate neighbourhood of the contact-surface. But distinct evidence was obtained of diffusion against the concentration gradient in cases where the electrostatic attraction surpassed the osmotic pressure, as foreseen by Nernst's theory. E. E. F.

GENERAL ELECTRICAL ENGINEERING.

69. *Testing Storage Batteries.* **R. Kennedy.** (Elect. Rev. 41. pp. 821–822, 1897.)—Reports on the tests of storage-cells are frequently very misleading, on account of the comparisons which are sometimes drawn between cells whose discharge rates per pound of plates are very different. A comparison of two types of secondary cells can only be fairly made by adopting the same rate of discharge per pound of plates. If a curve be drawn, for a given type of cell, connecting the pounds per kilowatt-hour of the cell with its rate of discharge in amperes, it will be found that the former quantity falls at first very rapidly, then more slowly until at about 100 amperes it becomes a straight line. Hence a comparison of two cells whose rates of discharge are very different is of no value whatever. A. H.

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70. *Electrically-operated Electric Engine-room Telegraph.* **C. Arldt.** (Electrotechn. Ztschr. No. 32. pp. 487–490, 1897.)—This apparatus, which was originally designed by Dr. L. Weber, of Kiel, and is constructed by the Allgemeine Elektricitäts-Gesellschaft, comprises a switching device whereby a magnetic field in the receiver turns synchronously with the lever of the transmitter, so as to produce a perfect rotary field. In this rotary-field indicator, the transmitter consists of an annular resistance-coil closed on itself and divided into sections each of which is connected to a bar of a circular commutator, over which moves a lever having a sliding contact-piece at each end. These sliding-contacts are adapted to engage with diametrically-opposite bars of the commutator, and are each connected, through sliding-brushes and fixed contact-rings, with terminals to which current is supplied from any suitable source. To three of the commutator-bars, at 120° apart (for which purpose the number of bars must be divisible by three), are connected conductors leading the current to the receiver. This receiver consists of a system of three (or a multiple of three) similar magnet-coils arranged with their axes at 120° apart around a pivoted arbor which carries a magnet and a pointer moving over a suitably-marked scale. The inner ends of these coils are connected together, whilst their outer ends are each connected to one of the conductors from the transmitter.

Assuming now, for illustration, that the transmitter and receiver are arranged so that the axes of the magnet-coils in the receiver are parallel to radii joining the centre of the commutator to the points of connection of the three conductors, and the lever carrying the contacts is placed with one contact over one of these points of connection, and the other contact midway between the other two of these points. When this is so, it is obvious that the inner pole of the magnet corresponding to the point of connection on which the sliding-contact rests, will be, say, of S polarity, whilst the inner poles of the other two magnets will be of N polarity, and consequently the N-pole of the magnet on the pivoted arbor will be attracted towards the magnet-coil whose inner end is of S polarity, whilst its S-pole will lie midway between the other magnets whose inner ends are of N polarity. It follows that the pointer will turn through 180° when the contact-arm is turned through a like angle, and that the results will be similar, in whichever of the three main positions the contact-arm is placed, and that the contact-arm and pointer will also remain parallel to each other for intermediate positions, since the currents along the three conductors and magnet-coils will vary regularly approximately according to a sine law, there being a difference of phase between them of 120°. The number of signals transmitted may be very large; for example, it is possible to so arrange the apparatus that it will indicate accurately from degree to degree, so that 360 separate signals can be transmitted.

When used for an engine-room telegraph, each transmitter is preferably combined with a receiver, so that when the indicator-arm on the bridge has been set to any position, the order can be acknowledged by the engineer in the engine-room by setting his transmitter to the same position; thus both the arm of the transmitter and the pointer of the receiver on the bridge will be on the same division of the dial. A bell can be rung automatically when the indicator-arms are moved.

When used as a water-level indicator, the contact-arm in the transmitter can be mounted on a spindle bearing a sprocket-wheel over which passes a chain connected to a float. The indicator can also be employed for a number of other purposes. C. K. F.

71. *Rubber and Compound Insulation.* (Elect. Rev. 40. pp. 521–522, 1897.)—The writer briefly refers to the various materials used for insulating cables, and states it as his opinion that, in spite of their high initial cost, rubber cables will in some cases always continue to be used. Impregnated or absorbent dielectrics have one marked peculiarity which is sometimes an advantage—they generally give warning of a developing fault, so that the latter may be located and the faulty section of cable withdrawn before there is an actual breakdown. An insulator known as "silex" has recently come into vogue in the United States; it consists of pulverised rock, and is commonly used in the form of powder, being packed around a bare conductor set in an iron pipe. It is non-hygroscopic, non-inflammable, cheap and durable. The writer refers to sudden breakdowns caused by rises of P.D. on account of electrical resonance, and mentions some methods used for preventing such breakdowns. A. H.

72. *Diatrine for Cables.* (Elect. Rev. 40. pp. 379–380, 1897.) —The article gives an account of some tests of a new rubber-like non-hygroscopic insulating material recently introduced by Messrs. Glover & Co., and by them called "diatrine." It is claimed for this material that it combines considerable mechanical strength and flexibility with high insulation resistance and dielectric strength. The tests given bear out the truth of this statement. The material is said to be very cheap. Its durability has still to be proved. A. H.

DYNAMOS, MOTORS, AND TRANSFORMERS.

73. *Dynamo for Three-Wire Distribution.* **M. Aliamet.** (Elect. Rev. 40. pp. 95–97, 1897.)—In feeding a three-wire network, it is an advantage to be able to use large units instead of groups of two smaller units coupled in series, as was done in the earlier plants. Various devices have been suggested and used from time to time in order to admit of the use of larger generators. One of the earliest consisted in the use of a battery of secondary cells coupled direct to the generator, the middle point of the battery being in connection with the neutral wire. Another plan is to provide the armature with two independent windings and commutators. Dobrowolski's method is to connect a reactance-coil across two insulated collars connected to diametrically opposite points in the armature winding, and to join the middle point of this coil to the neutral wire. There are disadvantages attending the use of all the above methods. A much better plan is one due to Müller, who places a third brush halfway between the main brushes, and connects this to the third wire. In order to prevent the destructive sparking, which would result in the case of an ordinary two-pole machine with this arrangement, Müller splits each pole into two parts separated from each other by a neutral zone in which the intermediate brush is placed. The machine has thus the appearance of a four-pole generator, although in reality it is only a two-pole one. In order to allow of the independent regulation of P.D. on the two sides of the three-wire network, the windings of diametrically opposite pole-pieces are joined in series, one set of windings being connected between the +brush and the intermediate one, the other between the latter and the −brush. A. H.

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74. *Series Winding of Compound Dynamos.* **L. H. Fry.** (Elect. Rev. 41. p. 540, 1897.)—Two cases are considered: (1) A dynamo which has already been built and provided with the necessary shunt-winding; (2) a dynamo not yet built and for which only the drawings and calculations are available. In the first case the author uses Fröhlich's formula to find the additional ampere-turns to be provided by the series-coils (the two constants of the formula and the drop due to armature resistance and reaction having been determined by experiment). In the second case, he first obtains the series turns required to compensate for drop due to resistance; and then uses Dobrowolski's construction for finding the turns required to balance armature reaction (in which the ampere-turns required to develop the E.M.F. on open circuit + those required to balance armature reaction are taken as the hypotenuse of a right-angled triangle, whose sides represent the armature ampere-turns and the resultant ampere-turns respectively). A. H.

75. *Equalising Connections for Compound-wound Dynamos.* **E. R. Keller.** (Elect. Rev. 40. pp. 540–541 and 555–556, 1897.)—The author discusses the action of the "equaliser" connection, first suggested by Gramme for series machines, and by Mordey for compound. The device consists in joining in parallel the brushes of all the machines which are working in parallel. The primary function of the equaliser is to prevent a possible reversal of polarity of any machine whose E.M.F. happens to fall below the normal value. It also assists to some extent in equalising the distribution of load among the various machines. The author works out the expressions for the currents in the various parts of a circuit fed by two compound machines working in parallel, and by considering a special case shows that the current carried by the equaliser may reach a high value. The currents in the series-windings are equalised the better, the lower the resistance of the equaliser. The author suggests a modification of the usual method of arranging the connections: he proposes to use an extra bus-bar, to which one end of each series-winding is permanently connected; the other end is connected through a single-pole switch to the corresponding bus-bar. A two-pole switch enables the armature of each machine to be connected between the remaining bus-bar and the auxiliary one connecting the series-windings. The resistances of the connections are so proportioned that the drop of potential from the brush of each machine through its series-winding to the bus-bar is the same for all. The currents in the series-coils of the machines will then be proportional to their capacities. A. H.

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76. *Automatic Regulator for Dynamos.* **F. Collischonn.** (Elektrotechn. Ztschr. No. 25. pp. 357–359, 1897.)—The author first gives a short sketch of the various types of automatic regulator already designed, and then proceeds to describe his own. The principle of this regulator is as follows:—In parallel with the dynamo are arranged two electromagnets which are each provided with an armature adapted to be pulled away therefrom by a spiral spring. The pull of these spiral springs is so adjusted that, when the P.D. between the terminals of the dynamo is normal, one of the armatures will be held away from its magnet, whilst—likewise at the normal P.D.—the second armature will not be pulled away from its magnet by the spring. From this it is obvious that the first electromagnet only acts when P.D.'s occur which are higher than the normal, whilst the second is only influenced by those which are below the normal. The circuit of the first electromagnet is provided with an interruptor in a similar manner to the electromagnet of an electric bell so that, when the current in its coils reaches a certain value, the armature will begin to vibrate, this action continuing until the P.D. falls to the normal. To produce vibration of the armature of the second electromagnet, when the P.D. falls below the normal, its circuit is permanently connected

across the dynamo terminals, and an auxiliary circuit, in parallel with the other and containing the interruptor, is provided for producing the vibration. This vibratory motion of the armatures is utilised to rotate a metal ring turning on a series of rollers, in one or the other direction according as one or the other armature is vibrating, this being effected by providing suitably-arranged pawls on the ends of the said armatures for engaging with a series of teeth formed on the periphery of the said ring. This ring is provided with a series of iron pins, mounted in but insulated from the ring and connected to a series of resistances which are gradually introduced or cut out of the field-magnet circuit of the dynamo as the ring rotates in one direction or the other, this being effected by means of a small quantity of mercury which remains in the lowermost part of a channel formed in the interior of the ring. These regulating resistances can either be mounted on the frame of the apparatus and be connected to the pins by means of flexible conductors, or they may be embedded in enamel on the ring itself. A commutator in connection with a series of resistances is also provided for enabling the apparatus to work at different P.D.'s. The apparatus is capable of maintaining the P.D. within 0·5 per cent. of the normal, and can also be used with alternating currents. C. K. F.

77. *Starting Monophase Induction Motors.* **R. Arno.** (Écl. Électr. 13. pp. 390-395, 1897.)—The method described consists of:—(1) Inserting, during the first moment of starting, a resistance of a proper value in each elementary winding of the rotor; this is chosen so as to make the whole resistance of the corresponding circuit slightly less than $2\pi n$L, L being the inductance of the circuit, and n the frequency of the current.

(2) Impressing on the rotor a very small initial velocity, such as is maintained by rotating the pulley by one quarter turn, or giving a pull to the belt.

(3) Reducing the additional resistance to nothing as the maximum speed is attained.

Tests on three motors of 12, 25, and 110 H.P. respectively seem to show that when started in this way, the starting-current is much the same as the full-load current, which is a great recommendation, since monophase induction-motors started by means of an initial rotary-field often require four or five times their full-load current at starting. W. G. R.

78. *First Cost of Transformers.* **G. Adams.** (Electn. 38. p. 112, 1897.)—The transformers considered are all of the closed magnetic circuit type, and built for outputs varying from 3 to 10 kilowatts. The frequency of the supply-current is taken as 100; the induction in the core as 3500 lines per square centimetre; the primary potential difference 2000 volts; the secondary potential difference 100 volts; the price of copper 10*d.* per pound, and the price of iron as 4*d.* per pound. The following table is given:—

Output in kilowatts.	Secondary Turns.	Primary Turns.	Weight of Copper in lbs.	Weight of Iron in lbs.	Cost of Copper.		Cost of Iron.		Total Cost of Iron and Copper.		Efficiency per cent.	Primary Current in amperes.	Secondary Current in amperes.	Iron Loss. in watts.
					s.	*d.*	*s.*	*d.*	*s.*	*d.*				
3	20	392	16	246	13	4	82	0	95	4	94·2	1·5	30	123
3	30	588	20	160	16	8	53	4	70	0	95·6	1·5	30	80
3	40	785	37	130	30	10	43	4	74	2	95·1	1·5	30	65
6	20	392	31	282	25	10	94	0	119	10	95·8	3	60	141
6	30	588	56	218	46	8	72	8	119	4	96·4	3	60	109
6	40	785	77	152	64	2	50	8	114	10	96·8	3	60	76
6	50	980	109	109	90	10	36	4	127	2	97·1	3	60	545
10	15	294	32	435	26	8	145	0	171	8	95·0	5	100	217
10	20	392	44	309	8	63	103	0	139	8	96·0	5	100	154
10	30	588	96	214	80	0	71	4	151	4	97·0	5	100	107
10	40	785	160	208	133	4	69	4	202	8	97·0	5	100	102

W. G. R.

79. *Constant Speed-Motors.* **W. Baxter.** (Elect. World, 30. pp. 633–636, 1897.)—This paper contains the following practical directions for ascertaining the field-winding of a differentially-wound constant-potential motor. Using an experimental coil on the field-magnet, adjust the exciting current until the required speed is obtained, the motor running light. Next, put on the full load, and reduce the exciting current until the same speed is reproduced. From the number of turns on the exciting coil and the current, we at once obtain the ampere-turns to be provided by the shunt and series coils respectively. A. H.

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80. *Speed-Regulation of Motors.* (Elect. Rev. 40. pp. 31–32, 1897.)—The article refers to a method of controlling the speed of direct-current motors, proposed by H. W. Leonard in a paper read by him before the American Institute of Electrical Engineers in Nov. 1896. This method consists in placing a rheostat in the field circuit of the *generator*. The author examines the advantages and disadvantages of this method as compared with the ordinary one of placing a resistance in series with the motor armature. In the latter case, the load must be tolerably constant, or else the motor will run by a succession of jerks; also, if it is desired to run at full load much below the normal speed, the power required is the same as at full speed. The new method does away with both these difficulties. On the other hand, it is not applicable in cases where the E.M.F. of the generator has to be maintained constant. The author thinks that when the field of the generator is weakened beyond a certain point, there may be serious difficulties on account of excessive sparking.

[In a letter to the Elect. Rev. of Jan. 15th, 1897, Mr. L. B. Atkinson states that the above method has been in use since 1893 in a large electrical haulage plant (130 H.P.) at the Trafalgar Collieries in the Forest of Dean, and, with carbon brushes, has given excellent results.—*Abstractor.*] A. H.

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81. *Setting up Large Generators.* **G. T. Hanchett.** (Elect. World, 30. pp. 665–667, 1897.)—The armatures of large multipolar generators are either lap-wound or else wave-wound. The latter winding is mainly used in high-voltage machines (500 volts or more), the former in low-voltage ones. If a wave-wound armature gives trouble on account of excessive heating caused by a local current, this can only be due to some defect in the armature itself, for any want of symmetry in the field would affect the two armature circuits equally. With a lap-winding, however, the armature may be perfect, and yet the machine may refuse to work satisfactorily, some sections of the winding carrying more current than others, or a section of high voltage supplying current to one of low voltage, thus driving the latter as a motor (this latter action is called "bucking"). Such troubles may be caused by: (1) the field poles not being magnetised to the same intensity; (2) the

armature not being truly concentric with the field. By connecting an ammeter in series with any brush, it is not difficult to ascertain whether the corresponding section of the armature carries its fair share of the load. Difficulties arising from unequal magnetisation of the poles are generally due to unequal ampere-turns on the exciting coils, and may be caused by a defect either in a shunt-coil (in which case the armature will heat when running on open circuit), or in a series-coil (when there will be a tendency to "bucking" at full load). A very simple method of finding the defective coil consists in separately exciting the machine and ascertaining the fall of potential over each coil; if the coils are wound with the same size of wire, they should have approximately equal resistances.—In setting up large generators, the field is generally adjusted in position by means of a taper-gauge, the same clearance being allowed between each pole-piece and the armature. In most cases this yields satisfactory results, but a further adjustment may be necessary. The field having been aligned as far as possible by means of the taper-gauge, the machine is excited, and the E.M.F. contributed by each section is ascertained. If the E.M.F.'s so obtained are plotted at equal angular distances in a polar diagram, and if the diagram exhibits symmetry, any want of equality is due to lack of alignment, and the defect is easily remedied; but if the diagram is distorted, then in all probability the defect lies in one of the exciting coils. The accurate adjustment of the field is a very tedious process, as the field has to be rigidly bolted down after each change of position; the adjustment is, however, made once for all, and then the relative position of the field and bed-plate is marked in two places with a cold chisel.

When a defect has to be remedied and the type of armature-winding is unknown, it may be ascertained in some cases by noticing the relative direction of the end-connectors. Frequently, however, these are covered with canvas, and the best plan then is to send a small current through the armature, and by means of a low-reading voltmeter ascertain the P.D.'s between one of the brushes and all the points where brushes might be placed with a lap-wound armature. From the voltmeter readings the nature of the winding may be inferred. A. H.

POWER DISTRIBUTION, TRACTION, AND LIGHTING.

82. *Life of Incandescent Gas Mantles.* **E. A. Medley.** (Elect. Rev. 41. pp. 824–826, 1897.)—The author gives the results, in the form of curves, of careful tests of various incandescent gas-mantles. These show that in all cases there is a rapid falling-off in light-giving power (in some instances, however, a slight initial rise is observed). Most of the mantles exhibit a deterioration of from 40 to 60 per cent. of their initial candle-power after 500 hours' use. The best results are obtained with the "Stabil" mantle, of German make, which after 500 hours' use retains about 75 per cent. of its initial candle-power. A. H.

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83. *Recent Progress in Arc Lighting.* **E. Thomson.** (Elect. Rev. 41. pp. 94–95 and 103–104, 1897.)—This paper deals with the various systems of arc lighting, and their relative efficiencies. Recently, machines capable of feeding 125 to 150 arc-lights in series, with a P.D. of 7000 volts between terminals, have been successfully employed. The author considers that for extended districts the series arc-lighting system will still hold its own; it involves a simple system of wiring, and is best adapted to the use of the cheaper carbons. In cities supplied with underground distributing mains, very good results are obtained by joining the lamps in parallel across the mains—a steadying resistance which absorbs a good deal of power being necessary. Enclosed arcs are coming largely into use; the P.D. may in this case be as much as 80 volts. The arc is long, and the ends of the carbons remain flat. The life of the carbons is very long, and hence there is an important saving of carbon and labour. The carbons must be of the very highest grade of purity, not too hard or dense. A thin deposit, nearly white in colour, is obtained on the inner enclosing globe; this is wiped off when recarboning the lamp. Alternating arcs are next considered. Owing to the periodical extinction of the arc, an alternate-current lamp is liable to "chatter" when first switched on, before the carbons have been heated up. The lower limit of frequency is about 40. Owing to their hum, alternate-current arcs are not suitable for indoor lighting. They seem to burn best with soft carbons furnishing a considerable amount of volatile matter. Although inferior to continuous arcs as regards luminous efficiency, they appear to be quite stable, so that no resistance or reactance is required when running off constant-potential mains; this, to some extent, makes up for their inferior luminous efficiency.—The efficiency of arcs increases with their size; thus, naked arcs, with 10 amps and 48 volts, may take for each mean spherical candle-power 1·2 watt, while arcs of 7 amps and 48 volts require 1·4 watt. A 4¾ ampere enclosed continuous-current arc (½ inch carbons) with clear inner and no outer globe takes 1·94 watts per mean spherical candle-power. A 16-

ampere 25-volt naked alternating arc is found to take 1·49 watts per mean spherical candle-power; an enclosed arc taking 2 watts.
A. H.

84. *Leading-in Wire for Incandescent Lamps.* **S. Cowper-Coles.** (Elect. Rev. 41. pp. 923–924, 1897.)—The author deals with the question of the cost of platinum for incandescent lamps, and estimates this at from ½*d.* to 1*d.* per lamp. He then gives an account of the various attempts which have been made from time to time to obviate the use of platinum. A. H.

85. *Alternating Current Arc Lamp.* **M. Aliamet.** (Électricien, 14. pp. 369–370, 1897.)—The chief feature of this arc-lamp is the regulating arrangement, which consists of a copper disc whose edge passes between the poles of two electromagnets, one of which is in series with the arc and the other in parallel with it. Co-axial with the copper disc is a pulley round which passes the cord to which the carbon holders are suspended. When the carbons are in contact only the series-coil acts, and the copper disc acting as an induction motor rotates in such a direction as to pull the carbons apart, and when the carbons are far apart the parallel electromagnet acts, and the disc rotates so as to bring the carbons together. W. G. R.

86. *Schuckert & Co.'s Arc Lamp.* (Elektrotechn. Ztschr. No. 32. p. 495, 1897.)—This lamp (German Patent, No. 90945) comprises a rocking-frame carrying a train of wheels having, on the first arbor, a drum connected to the movable carbon-holder by a cord or wire, and, on the last arbor, a brake-wheel adapted to engage with one arm of a weighted lever which normally rests against a stop in a definite position. The rocking-frame rests on horizontal racks by means of toothed wheels so that, as it rocks, it moves laterally, and thus the motion is made smoother by doing away with an axis turning in stationary bearings. To control the motion of this rocking-frame, it is provided at its ends with curved surfaces engaging with rollers mounted on the cores of the regulating solenoids. C. K. F.

87. *Arc Lighting with Rectifiers.* **C. D. Taite.** (Electn. 39. p. 374, 1897.)—In this article the use of rectifiers is advocated, because of (1) the efficiency, (2) the small upkeep, and (3) the small floor-space required. At Southport, where forty-three arc-lamps are seen in series, the input of the rectifier averages 33 units per hour and the output 30¾ units, giving about 93 per cent. efficiency at full load. At half-load the efficiency is 87·4 per cent. The upkeep of the rectifier is only 2·35 per cent. of the gross income from the lamps. W. G. R.

88. *Suspension for Arc Lamps.* **H. Rentzsch.** (Elektrotechn. Ztschr. No. 29. pp. 419–420, 1897.)—An improved form of windlass is described with sliding contacts for use in raising and lowering arc-lamps. It consists of a base-plate carrying insulated terminals and also a fixed hollow shaft on which turns a disc forming one side of a flanged drum for receiving the flexible conductors leading to the arc-lamp, the remaining part of this drum being detachably secured to the said disc and having at its other end a journal turning in a bearing formed in the removable cover of the apparatus. The hollow shaft is provided with two insulated contact-rings arranged at its free end within the rotary drum connected to the terminals by insulated conductors passing through the passage in the interior of the shaft. In the interior of the drum are mounted insulated brass pillars carrying brushes which are adapted to engage with the contact-rings on the hollow shaft, these pillars having clamps to receive the insulated conductors leading to the lamp. The drum is also provided with a spur-wheel adapted to engage with a pawl or detent on the base-plate so as to enable it to be locked in any desired position; the drum is turned by means of a detachable crank-arm having a squared end fitting into a square hole in the journal on the removable part of the drum. To attach or dismount the conductors, the cover and detachable part of the drum can be removed and access thus obtained to the connections. C. K. F.

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89. *Power Factors of Electrical Plants.* **R. Klasson.** (Electn. 39. pp. 319–320, 1897.)—This article describes some experiments made on the effect of synchronous motors or rotary converters on the power factors of electrical plants. If the load consists partly of induction motors, a highly synchronous motor or rotary converter has the effect of increasing the power factor; and the author considers that it is advantageous to overexcite rotary converters when running on light load, since for a given output the current in the transmission mains is thereby diminished and the necessary capacity of the generating plant correspondingly diminished.

W. G. R.

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90. *A* 10,000 *Volt Transmission Plant.* **W. Klug.** (Electn. 38. pp. 469–472, 1897.)—This is a description of the three-phase plant between Eichdorf and Grünberg. The power is developed at a voltage of 225, transformed up to 10,000 at Eichdorf, and down to 120 volts at a single step at Grünberg. The transmission mains consist of bare copper wire 26 sq. mm. in section in the intervening country, and of the same size of indiarubber insulated wire when entering the towns. The lines are throughout protected by lightning-protectors—one for each line wire. The spark-gap is between bent copper strips held on high-pressure insulators. The line is connected to one of these strips and the other is connected to earth. As a further protection from lightning, a

barbed wire runs above the line, being fixed to the tops of the poles and earthed at every sixth pole. Experience shows that this system of protection from lightning is efficient. W. G. R.

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91. *Jungfrau Electric Railway.* (Écl. Électr. 13. pp. 25–27, 1897.) —This article includes a table stating the details of the line. The line proper commences at the Scheidegg Station as a branch to the Wengernalp Railway. At the Mœnch Station there will be a crossing for the ascending and descending trains. The first section from Scheidegg to the Eiger Glacier is now almost completed. The tunnel commences about 2·5 km. from the starting point and extends, with few interruptions, to the summit. The power is obtained from the two branches of the Lutschine at Burglauenen and Lauterbrunnen. Tests show that in one locality 9000 H.P. are available, and in the other branch 2130 H.P. At the latter, the Lauterbrunnen station is being installed. The output will be 500 H.P., being sufficient for traction on gradients of 25 °/₀ at speeds of 8·5 kilometres per hour, and also for supplying power for heating and lighting. The power at the axles of a train, with a load of 26 tons, will be 211 H.P., and the total working efficiency 50 °/₀. The stations are to be lit from batteries of accumulators charged *in situ*. During construction the current will be employed for working drills and cooking apparatus.

The Lauterbrunnen station will be capable of supplying 2130 H.P. for driving four trains simultaneously. The provisional station consists of two turbines of 500 H.P., and two turbines of 25 H.P. for driving exciters. The large turbines are of the Girard type with horizontal axes, and governed for the large variations of load on the line. The small turbines are also fitted with automatic regulators. The total cost of the Lauterbrunnen installation amounts to 558,800 francs, or 260 francs per H.P. The majority of the schemes submitted were for the 3-phase system. Each turbine is direct coupled to a 3-phase generator running at 380 revs. p. m., and working at a frequency of 38 ~ and 7000 volts.

The contract stipulates that the inhabitants of the Commune of Lauterbrunnen are to receive, free of charge, 50 H.P. for the whole year, this power being supplied at a pressure of $\frac{7000}{\sqrt{3}}$ volts by one of the phases. The primary conductors run to the Scheidegg station, where the pressure is reduced to 500 volts

The line consists of three hard-drawn copper wires, 7·5 mm. dia., which are run up to an altitude of 1300 metres. The secondary line runs overhead as far as the entrance of the tunnel; it consists of copper wires 9 mm. dia., supported by span wires. The same posts carry telephone wires and the test lines. The conduit system to be used in the tunnel has not yet been decided upon.

Twelve transforming stations are placed along the line. One is specially designed for working the lift; the others are spaced 1 km. apart on gradients of 25 °/₀, and 1·75 to 2 kw. along gradients of 10 to 15 °/₀. The trains will follow one another at intervals of 1 kilometre or 7 minutes, the stoppage at the crossing-point will be 20 minutes. This crossing station is connected to the line by a lateral tunnel several hundred metres long, and along which will run a light car.

The trains will consist of a locomotive and of a trailer car. The weight of the locomotive alone is 12 tons. The 125 H.P. motor used on the locomotive runs at 800 revolutions, and this maximum power of 125 H.P. corresponds to a current of 235 amperes per phase on the secondary line.

The gauge of the line is 1 metre, and the two pinions gearing in the rack are 70 cm. dia. each, the maximum force at the teeth is 6500 kilos, and the diameter of the wheels 60 cm.

The locomotive is fitted with the following brakes:—(1) On the axle of the dynamo is an electric brake which comes into action when the supply-current ceases. An electric regulator is combined with this brake to switch off the current should the speed become too great. The switch can also be operated by means of a cord fixed outside the car. (2) A hand-brake, consisting of levers and bronze shoes acting on the motor pinions. (3) A brake grip, the bronze shoes of which act on the lateral faces of the rails; this brake may be employed for regulating the speed on descending.

The carriages have an actual weight of 2000 kg., and can carry 8000 kg., the ratio of dead to useful weight being 32 °/₀.

The author will publish further data when the line is more advanced. L. J. S.

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92. *Electric Lighting of Vehicles on the Jura-Simplon Railway.* **C. Jacquin.** (Écl. Électr. 12. pp. 552–562, 1897. See also Écl. Électr., Aug. p. 392; and La Lumière Électrique, 1894.)—At the beginning of 1894 electric light had been applied to all the trains on this line, it became a difficult matter to charge all the batteries from the Fribourg station. The Jura-Simplon railway therefore took advantage of the large hydraulic station which had been erected at Bienne in 1893; they made this a second charging centre for their batteries. A sub-station was installed as at Fribourg, serving for lighting purposes as well as for charging accumulators. The central station at Bienne was installed by the firm of Lahmeyer of Frankfort, and obtains its power from a 50-metre water-fall driving two turbines of 250 H.P., each working two 3-phase generators of 65 kw. each. The power at 80 volts provided by the generators is transformed in the station to a pressure of 1800 volts, and is then sent through two primary circuits consisting each of 3 bare copper wires.

One of the lines, 2·1 km. long, with wires ·6 mm. dia., extends to the Jura-Simplon works 1 km. from Bienne, and is there connected to a rotary converter, running as a 3-phase synchronous motor, and which itself is used for power purposes as well as for supplying current at 110 volts for lighting. This machine converts 90 kw., 50 to 60 H.P. of which is supplied as motive power and the remainder for lighting.

The secondary primary line, which is 3·2 km. long, consists of 3 copper wires 7 mm. dia., and supplies 130 H.P., half of which is for the station at Bienne and the other half for lamps and motors in the town. Lahmeyer converters being here used for distribution at 120 volts. These converters consist of a rotating-drum armature and of a single coil 8-pole field. The armature on one side carries three collector-rings for the high-tension current and a commutator on the other side. The high-tension winding is placed in slots in the armature, and the low-tension winding over this. The two windings are separated by a copper earth-shield. The converters, as is the case of synchronous motors for polyphase alternating currents, can start alone. If the field be unexcited and the continuous-current side disconnected, and the high-tension side alone be closed, the motor will run up to speed owing to reactions on the pole-pieces, and under these conditions will have an appreciable torque. The converter can be started in this manner in two minutes. The converters are under some conditions started as shunt-motors from the continuous-current side, in which case a phase-indicator has to be employed. A part of the continuous current passes to twelve battery-charging circuits. The batteries are removed from the railway-carriages for charging purposes. The original cost of maintenance of 650 batteries, as contracted for by the Société de Marly, varied from 23 to 25 francs per battery. The Company then undertook the maintenance of the batteries themselves.

The arrival and departure of all the accumulator boxes is recorded in a register. When fully charged, the voltage of 9 cells must not amount to less than 19 volts. The batteries are enclosed in three-chamber ebonite boxes protected by an outer wooden case. As in Switzerland the trains do not run after midnight, the batteries can be completely recharged in 9 hours. There are 425 batteries in use and 250 batteries kept as a reserve. The lamps, owing to their low voltage, cost 2½ francs each, and their life varies from 300 to 600 and 700 hours.

The central stations mentioned above supply power by meter at the low rate of 0·05 franc per H.P. hour, or 0·067 franc per kilowatt-hour. A single battery supplies current to four 10-candle-power lamps for 1000 hours each year; and the total cost of maintenance amounts to only ·0031 franc per lamp-hour of 10 candles.

Taking into account the efficiency of converters and accumulators, the expenditure of 30 watts for a 10-c.p. lamp is very low as compared to the price of gas or oil. The Jura-Simplon railway is, however, acknowledged to be working under exceptionally favourable circumstances. It may be said that the greater the railway system the greater the cost of electric lighting.

The author concluded by the statement that when the applications of electric lighting are restricted to particular cases possessing favourable conditions of working such as the above, then many difficulties are eliminated, and this mode of lighting may then well compete with the other systems. L. J. S.

93. *Electric Railway Traction.* **C. T. Child.** (Elect. World, 30. pp. 443–448, 1897.)—The author discusses the possibilities of electric traction on the Philadelphia local railway-lines. A 3-phase transmission at 5000 volts is recommended, coupled with sub-stations, where the energy would be transformed into direct current at 750 volts, the distribution being effected in conjunction with a storage-battery and a booster at each sub-station, so that the load on the central station is maintained practically constant. The main points of the system are considered, and an estimate given of the capital outlay and working expenses. W. R. C.

94. *Electric Traction.* **G. Pellissier.** (Écl. Électr. 13. pp. 309–313 & 349–357, 1897.)—The author gives an account of various appliances and systems of electric traction, of which the following is a brief summary:—

In the device of E. C. Parham for extinguishing arcs in controllors a separate magnet is employed for each contact, instead of one electromagnet as used by Elihu Thomson, thereby effecting an economy in the necessary current. The automatic mechanism of H. F. Parshall for preventing the speed of a car exceeding a given value is described, and also the electric brake manufactured by the Union Elektricitäts-Gesellschaft. The Heilmann system has been applied by Patton to tramcars with good results. The car carries an oil-engine, a dynamo, a battery of accumulators, and one or two motors. It was used in conjunction with from one to five trailer trucks. The consumption of gasoline amounted to 15 gallons per day of 10 hours (no figures are given as to weight, etc.). A somewhat similar car is due to L. H. Nash: this carries no battery, but an increased current for slow speed of motors is obtained by means of a differential winding. Allusion is made to the method of Snell, Grove, and Hills for the working of automatic commutation of current on crossings where a three-wire system is employed; and an account is given of the Lachmann mechanism for the commutation of current where a single trolley-wire is used in place of two wires, and is divided into alternate + and — sections. Max Déri surmounts the difficulties experienced in using alternate-current motors upon cars by employing a subsidiary direct-current motor and battery of accumulators to be used for the purpose of starting only. In Meacock's system of distribution the conductor is surrounded by indiarubber and is placed in the groove of the rails. The rubber case consists of two parts, forming two longitudinal joints, which are normally closed. In the upper one of these a metallic blade attached to the car slides and makes the necessary contact. A somewhat detailed description is given of the conduit and surface systems of C. F. de Redon, of C. F. P. Stendebach and O. H. Linker, of Demeuse, and of Adamson.

The paper concludes with a brief account of J. Steffen's station indicator, and of André and Silbermann's method of working switches from a car. W. R. C.

95. *Electric Traction in Brussels.* **M. Travailleur.** (Écl. Électr. 13. pp. 434–443, 1897.)—The author gives an account of the conduit tramway system recently laid down in Brussels. W. R. C.

96. *Accumulator Traction at Ostend.* **E. Pierard.** (Électricien, 14. pp. 305–308, 1897.)—The cars are constructed to carry 50 persons, with seats (inside only) for 24. The weight, unloaded and without accumulators, is 7½ tons. That of the accumulators is not given; but it is to be inferred that the weight somewhat exceeds 2½ tons. The truck is carried on four wheels, and is furnished with two 18-kilowatt Westinghouse motors, coupled to the axles by single-reduction gearing of 1 : 5. The battery consists of 108 cells contained in 12 boxes, which appear to be placed beneath the seats. The capacity amounts to 140 ampere-hours at a discharge of 50 amperes. The time requiired for charging varies from ¾ to 2 hours according to circumstances, the necessary current being supplied by a steam belt-driven Westinghouse dynamo. All active material falling from the positive plates is carefully collected and reapplied from time to time. Up to the present, the running expenses have been low. The coal consumed amounts to 5·1 lbs. per car-mile, and the tractive force is said to vary from about 18 lbs. per ton at starting down to 9 lbs. at a speed of 11 miles per hour on Vignole rails. W. R. C.

97. *Power Transmission.* **C. P. Steinmetz.** (Elect. World, 30. pp. 586–588, 1897.)—The author gives a detailed account of the electrical plant for the transmission of power from Mechanicville to Schenectady, a distance of about eighteen miles. The features of interest are:—(1) the generators, which are three-phase alternators of the revolving field type generating direct at 1200 volts, thus obviating the necessity of step-up transformers; and (2) the use of synchronous motors and rotary converters at the receiving end of the line. The synchronous motors are adopted in preference to induction-motors, on account of the control they give over the power-factor of the plant. W. G. R.

98. *Zickler's Equal Cost Diagram.* (Elect. Rev. 40. pp. 774–776, 1897.)—The writer gives an account of Zickler's investigation with respect to the relative cost of a private generating plant and a supply from a central station. If

P=capital required for purchase of machinery and accessories,
Z=maximum capacity of plant in hectowatts,
T=number of hours per annum of supply per hectowatt,
p=fixed percentage charge on P for interest, depreciation and repairs, and attendance,
β=expenditure for fuel, cleaning, and lubricating materials per hectowatt-hour,
α=price per hectowatt-hour charged by supply company,

then the two costs will be equal when

$$\frac{p}{100}P+\beta ZT = \alpha ZT. \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

By examining price-lists of dynamos, steam-engines, etc., Zickler finds that P may be expressed in the form

$$P = AZ+B,$$

where A and B are constants. The following values of A and B are given by the writer, P being expressed in shillings :—

	Constant A.	Constant B.
Steam-engines......	9·3–17·5	975–2400
Portable engines....	32·3–41·9	2500–5200
Gas-engines...	28–52·3	950–3500
Dynamos.	13	550

Putting $\frac{p}{100(\alpha-\beta)}=C$, $CB=C_1$, and $CA=C_2$, equation (1) may be written in the form

$$T = \frac{C_1}{Z}+C_2,$$

which is the equation of a rectangular hyperbola. If the point corresponding to given values of Z and T falls in the region between the curve and the coordinate axes, a central station supply is cheaper; if it falls outside, a private plant is more economical. A. H.

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99. *Electric and Frictional Brake.* **M. Déri.** (Elektrotechn. Ztschr. No. 29, p. 422, 1897.)—In this brake the retardation and stoppage of electrically-propelled vehicles, or of vehicles on which an electric current is available, is effected electrically by means of eddy-currents so long as the motion is rapid enough, but when the motion becomes slow, by frictional contact. The transition from one to the other takes place automatically, so that the axle of the vehicle can be finally brought to rest.

This apparatus comprises a circular series of electromagnets fixed, by means of a yoke-plate common to them all, to the frame of the vehicle so that their pole-pieces are concentric with one of the axles, the coils being so wound that the pole-pieces are alternately N and S. The ends of these pole-pieces are so shaped as to lie in a conical surface, and are adapted to engage with an armature which is made in the form of a hollow cone of similar pitch to the conical pole-pieces, and is capable of sliding longitudinally through a limited distance on the shaft, but is constrained to rotate therewith by means of slots and feathers. The said armature is also provided with brackets in which are pivoted curved arms arranged to move in a plane passing through the axis of the shaft, and having balls or weights at their outer ends. The inner ends of these arms are forked and adapted to engage with a loosely-fitting collar or sleeve on the shaft, this collar being pressed away from the electromagnets by a spring, and the pivoted arms above-mentioned being so curved that the centrifugal force, due to the rotation of the balls, will cause the inner ends of the arms to press the collar against the spring and so force the armature away from the pole-pieces. The various forces are so adjusted that the magnetic force can overcome the force of the spring alone, but not the combined action of the spring and the centrifugal force of the weights, when the vehicle is running at its normal velocity.

As long as there is no current in the magnet-coils, the armature is held away from the pole-pieces of the magnets. When the magnets are energised, during motion of the vehicle, the armature and pole-pieces are, at first, not brought into contact with each other, but eddy-currents are induced in the armature, which currents produce a powerful retarding force. When the speed has been reduced by these means to a certain degree, the centrifugal force caused by the rotation of the balls is insufficient to hold the armature and pole-pieces apart against the tractive force of the electromagnets, and frictional contact between these parts takes place, which speedily brings the vehicle to a standstill. In this manner wear is reduced to a minimum. C. K. F.

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100. *Small Lighting Plants.* **F. C. Reeve.** (Elect. World, 30. pp. 672–673, 1897.)—This paper deals with the advantages and disadvantages of private electrical plants over purchasing power from Supply Companies. As regards cost and economy the author concludes that private plants have the advantage by amounts varying from 13 to 36 per cent. on the cost per candle-power hour for plants supplying from 25 to 100 lamps of 16-candle power, and concludes that the tendency will be that manufacturers and owners of large shops will produce their own electricity, whilst the sphere of Supply Companies will be to cater chiefly for private houses.

The following table of comparison is of interest, since it gives details of plants in actual operation:—

Table of Costs of Operating Plants.

Max. capacity of plant in 16-c.p. lamps		25	50	75	100
Average first cost of plant		$400	$650	$900	$1100
Interest and depreciation, at 15 per cent.		60	97·5	135	165
Cost of gas and lubricating-oil per lamp-hour		0·30	0·26	0·25	0·24
Cost of gasoline and lubricating-oil per lamp hour		0·16	0·14	0·13	0·12
Cost per lamp-hour of running with full load 300 hours per year	Gas	1·01	0·91	0·81	0·70
	Gasoline	0·96	0·79	0·70	0·67
Saving, per cent		13	13	14	15
Cost per lamp-hour of running with full load 600 hours per year	Gas	0·70	0·59	0·53	0·42
	Gasoline	0·56	0·47	0·42	0·40
Saving, per cent		20	20	21	23
Cost per lamp-hour of running with full load 1200 hours per year	Gas	0·50	0·42	0·39	0·38
	Gasoline	0·36	0·30	0·27	0·26
Saving, per cent		28	29	33	33
Cost per lamp-hour of running with full load 1800 hours per year	Gas	0·43	0·37	0·34	0·33
	Gasoline	0·29	0·25	0·23	0·21
Saving, per cent		33	33	33	36

W. G. R.

TELEGRAPHY AND TELEPHONY.

101. *Localising Faults.* **J. Rymer-Jones.** (Elect. Rev. 40. pp. 4–6, 1897.)—The method considered by the author refers to the determination of the position of a partial earth or complete break by tests from one end only. Kingsford and Kennelly have given methods for this case. When using testing-currents of ratios 4 : 2 : 1, Cann noticed that an even closer approximation to the actual position of a break than by using the Kennelly formula may be obtained by the aid of the formula:—

$$\text{Distance of fault} = A + B - C \text{ units},$$

where A = measured resistance with the strongest current,
B = „ „ intermediate „
C = „ „ weakest „

The author finds, as the result of numerous tests, that

$$B - A = \cdot 5576\,(C - B),$$

and that this relation holds both for widely different currents and also for large and very small exposures. Hence Cann's formula reduces to

$$\text{Distance of fault} = 2\cdot 5576\,B - 1\cdot 5576\,C,$$

and only two measurements, B and C, to instrument zero, need be taken. The author discusses the best conditions for the test, and recommends 10 and 5 milliamperes as the most suitable testing-currents. When the exposure is very small, the calculated resistance to the fault is somewhat higher than its true value, which it may exceed by about 30 units in extreme cases. A. H.

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102. *Telegraphy.* **A. Hess.** (Écl. Électr. 13. pp. 385–390 & 455–458, 1897.)—In these two articles the author gives an account of the so-called "Marconi" system of telegraphy, the chemical system of Delany, and the synchronograph of Crehore and Squier. The articles contain nothing that is new, but the references may be useful. R. A.

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103. *Type-printing Telegraph.* (Electn. 40. pp. 50–51, 1897.)—A type-printing telegraphic receiver, called a "telescriptor," the invention of Bernard Hoffmann, of Austria, is described. In appearance the instrument somewhat resembles a type-writing machine. Each key on the key-board is associated with a corresponding bar of a commutator. On the same axle as the commutator is the type-wheel, arranged so that each bar corresponds to a letter or to a figure. This axle also carries ratchet-wheels for controlling and synchronising the type-wheel. If an earth-return is used, only one line-wire is necessary. The line-current is unidirectional, and the same instrument is available for sending or for

receiving. One pole of the line-battery is connected to earth; the other is connected to the key-board, and thence to one or other of the bars of the commutator. From the commutator-brush, connection is then made through the coil of a relay to line. The local circuit of the relay controls the clockwork that drives the type-wheel; it also actuates an electromagnet for approaching or withdrawing the slip to and from the type-wheel. The instrument is very simple, but its working speed is small; it would seem to have a place between the Hughes' printer and the Wheatstone's A.B.C. apparatus. R. A.

104. *Applications of the Coherer.* **A. C. Brown.** (Electn. 40. pp. 91–93, 1897.)—The author gives a prospective view of the probable applications of the coherer principle. The practical uses may be summarised as:—(1) Wireless telegraphy over moderate distances; ship signalling, military telegraphy, fire alarms, and police calls. (2) The cases where a broken circuit or any short distance requires to be bridged without direct connection, *e. g.* where a wire runs for the greater part of the distance: these cases include railway signalling, communication to lightships, and working through faulty submarine cables. (3) Relay circuits for land-lines and for submarine telegraphs. (4) Telegraphing over great lengths of bare submerged wires, uninsulated submarine cables, or sheathing wires. The limitations of the use of the coherer are carefully discussed; signalling over great distances is considered impracticable; so also is "syntony," except for laboratory purposes. Reports as to the possibility of signalling into iron boxes are discounted. A system of selective receivers is described, whereby each receiver in any municipality may be arranged to respond to a particular set of rated signals, depending upon mechanical harmonic vibration. The most promising application seems to be the use of the coherer in connection with bare submarine cables; the author indicates that several thousands of miles might thus be traversed. R. A.